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PROCEEDINGS

OF THE

ASSOCIATION OF OFFICIAL SEED ANALYSTS

OF

NORTH AMERICA

1938

IMPERIAL MYCOLOGICAL INSTITUTE
4 OCT 1939

Thirtieth Annual Meeting
Guelph, Ontario, Canada
June, 1938

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W. O. Whitcomb
M. T. Munn
E. H. Toole

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THIRTIETH ANNUAL MEETING
OFFICERS AND COMMITTEES
1937-1938

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PROCEEDINGS OF ASSOCIATION OF OFFICIAL SEED ANALYSTS
OFFICERS AND COMMITTEES

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Lovina M. Caldwell, International Seed, Inc., New York, New York
Vera Drake, Ransom Seed Laboratory, Los Angeles, California
Fred S. Emmett, National Seed Laboratory, Toledo, Ohio
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Mary Teschke, Coop. G.L.F. Mills, Syracuse, New York
Leota Thurlimann, Vaughan's Seed Store, Chicago, Illinois
Harry E. Vegiard, Crosman Seed Co., East Rochester, New York

REGISTER

Other Visitors

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Mrs. Clifford Corneli, St. Louis, Missouri
Harold Goodwin, Bloomington, Illinois (Funk Bros. Seed Co.)
Grace Higgins, Fargo, North Dakota
R. J. Laible, Bloomington, Illinois (Funk Bros. Seed Co.)
N. D. MacKenzie, Chatham, Ontario, Canada (Prod. Services, Plant Prod.)
M. A. McCall, Washington, D. C. U.S. Department Agriculture)
O. McConkey, Guelph, Canada (Ontario Agriculture College)
H. H. Miller, Bloomington, Illinois (Funk Bros. Seed Co.)
Mrs. H. H. Miller, Bloomington, Illinois
Mrs. M. T. Munn, Geneva, New York
Earl M. Page, St. Louis, Missouri (Corneli Seed Co.)
Robert C. Teschke, Syracuse, New York
M. Tobin, Toronto, Ontario, Canada (Plant Products)
W. A. Wheeler, Washington, D. C. (U. S. Department Agriculture)
W. T. G. Wiener, Ottawa, Ontario, (Canadian Seed Growers Association)

THIRTIETH ANNUAL MEETING
MINUTES

THIRTIETH ANNUAL MEETING, GUELPH, ONTARIO, CANADA
JUNE 21-24, 1938

The 30th annual meeting of the Association of Official Seed Analysts of North America was held at the Ontario Agricultural College, Guelph, Ontario, June 21-24, 1938.

The total attendance was 87, of whom 50 were representatives of 26 official laboratories, 21 were commercial analysts, and 16 visitors.

Dr. G. I. Christie, President of the Ontario Agricultural College, gave the welcoming address. During the course of the meeting, addresses were given by Mr. W. T. G. Wiener, President of the International Crop Improvement Association, Mr. Earl M. Page, representing the American Seed Trade Association, Mrs. Ethel E. Pattison, representing the Association of Commercial Seed Analysts, and Mr. W. A. Wheeler, of the Bureau of Agricultural Economics, U. S. Department of Agriculture, as well as by various members of the Association.

Papers and reports presented at the meeting disclosed outstanding progress in methods of seed testing, development of equipment, and results in obtaining uniformity of interpretation through the use of referee samples. The legislative committee reported progress in investigations which will result in recommendations for standards of germination for vegetable seeds. Dr. M. A. McCall of the Seed Policy Committee of the U. S. Department of Agriculture, briefly explained the progress which has been made in the discussions between the Seed Policy Committee and representatives of the American Seed Trade Association in the development of the proposed new Federal Seed Act.

A new development that will no doubt prove of marked influence is the activity of the public service committee in the matter of educational activities and appreciation of the value of good seed. The Association does in this way accept the challenge of the Secretary of Agriculture presented before the Association at its 1937 meeting when he said:

> "**** I suppose not one person in a thousand appreciates as completely as he or she should the importance of the best kinds of seed, the importance of the difference between good seeds and bad seeds. You, of course, appreciate that but you haven't driven home the appreciation of the difference in the public mind to the extent that you should."

Mr. Wright acted as toastmaster at the annual banquet. Gifts were presented to Miss Sirrine by the official analysts as well as the commercial analysts, in appreciation of her long service and lasting contribution in seed analytical work.

The following actions were taken by the Association at the business session:

1. It was moved and carried; that the report and recommendations of the qualifications committee be accepted; that the recommendations be included in the Proceedings and distributed as separates to the heads of laboratories and correct officials in the various governmental agencies; that it is not the intent of the Association that these recommendations should cause the dismissal of persons who may be qualified as a result of past experience.

2. It was moved and carried that the following recommendations of the research committee be adopted by the Association as a sound policy for this committee and that they be carried out as soon as possible.

(a) That the Association again record its conviction that referee testing affords the best means for analysts to (1) meet on common grounds, (2) compare

the results of their testing methods, and (3) study the reasons for differences. Every analyst, therefore, should do some referee testing regardless of limited facilities and experience.

(b) That more analysts avail themselves of opportunities for working on problems in seed testing in which two or more laboratories can take part. This can be done to advantage through the research committee.

(c) That the research committee adopt as one of its major functions, a program of applying the results of fundamental research to seed laboratory practice. New techniques in seed analysis, new leads which appear to have merit should be investigated by the committee and recommendations made after adequate trial.

(d) That the Association through its research committee encourage laboratories which are so equipped to investigate any phase of seed research in which one or more analysts may be interested.

(e) That the research committee cooperate with the legislative and other committees in helping to solve problems on which the research committee has or may obtain information.

(f) That a sub-committee of analysts trained in plant pathology be organized to study the application of phytopathological techniques to seed laboratory practice. The laboratories in Ottawa, Iowa, Massachusetts, and New York should be represented and others added in due time. Chairmanship of the sub-committee should be rotated annually.

3. It was voted that in view of the length of the report of the research committee, the manner of its publication should be determined by the publications committee.

4. The association voted to acknowledge receipt of the report from the legislative committee of the American Seed Trade Association upon their consideration of the Uniform State Vegetable Seed Law. This report indicated the wish of the Seed Trade to postpone consideration of the Uniform Seed Bill pending action on the proposed new Federal Seed Act.

5. The Association voted to defer adoption of the proposed constitution and referred it to the incoming constitutional committee.

6. The following report of the resolutions committee was adopted:

(a) Be it resolved: That the Association of Official Seed Analysts at their 30th annual meeting held at Guelph, Ontario, June 21-24th inclusive wishes to express its thanks and appreciation to:

(1) The Ontario Department of Agriculture for the use of the auditorium, lantern, and other facilities.

(2) To Dr. G. I. Christie, President of the Ontario Agricultural College for his cordial welcome and interest in the work of our Association.

(3) To Dean Sands of the Ontario Agricultural College for providing convenient accommodation for all delegates.

(4) To Miss Beck, Dietitian, and her associates for providing tasty meals throughout the convention.

(5) To Professor McConkey for escorting the delegrates around the experimental plots.

(6) To Mr. W. H. Wright for his instructive and interesting exhibit of colored plates of Cruciferae seeds.

(7) To Mr. F. W. Baldwin, Director of Athletics, for providing the use of the swimming pool for the delegates.

(8) To Mr. Bell, Manager of the O.A.C. baseball team for loaning

baseball equipment for the softball game.

(9) To Professor Blackwood, Professor Raitby, Dr. Leggatt and Dr. Porter for their delightful entertainment which added much to our sing song.

(b) Be it further resolved: That there be continued a fostering of:

(1) A cordial relationship between members of the Association in the United States and Canada and the fine cooperation between the laboratories.

(2) An appreciation of the activity of a greater number of laboratories, both official and commercial, participating in referee tests as an educational feature.

(3) The discouragement of trading in uncleaned and untested seed between producer and consumer.

7. The following recommendations of the executive committee were accepted:

(a) That abstracts or complete papers be submitted to the program committee prior to the annual meeting.

(b) That all reports and papers be in final form and handed to the Secretary before the end of the meetings.

(c) That all motions be submitted in writing.

(d) That the minutes be approved by the executive committee prior to publication in the Proceedings or elsewhere.

(e) That the Secretary-Treasurer be authorized to pay the research committee members and the editor of the News Letter for necessary postage and other items of expense in connection with the work of that committee and the News Letter,

(f) That favorable action be taken on the question of setting up qualifications for membership in the Association.

8. The Association adopted the following resolution:

Whereas, the practical application of much of our analytical and testing work depends upon enforcement, be it:

Resolved, that the Association urge more uniform, consistent, and widespread enforcement of seed control laws and regulations.

9. It was voted that the chairman of the legislative committee for the Association express to Dr. McCall our appreciation of his appearance before the Association and assure the Seed Policy Committee of the U. S. Department of Agriculture that we are keenly interested in Federal seed legislation and wish to present to the proper authorities at the proper time such suggestions as may seem advisable.

10. The Association voted to authorize and urge the legislative committee to ascertain as soon as convenient any objections or specific changes in the proposed Federal Seed bill it is deemed advisable to make and to present them at the proper time to the appropriate committee or committees.

11. It was moved and carried that the Association of Official Seed Analysts of North America go on record as opposing the proposed "Master Sample Plan", which has been proposed by the American Seed Trade Association as an amendment to H. R. 10816, commonly known as the "Coffee Seed Bill", as unsound and impractical in seed law enforcement and that the Seed Policy Committee of the U. S. Department of Agriculture be so advised.

The canvass of the ballots showed the election of Dr. R. H. Porter, Ames, Iowa, as Vice-President, and Mr. W. A. Davidson, Washington, D. C., as Secretary-Treasurer. Mr. L. N. Allen, Montgomery, Alabama, automatically becomes President for the coming year.

The 31st annual meeting will be held in Madison, Wisconsin, on August 1-5, 1939.

The chairmen of the standing committees were appointed by Mr. Allen as follows: Public Service Committee, Mr. F. A. McLaughlin, Amherst, Massachusetts; Legislative Committee, Mr. C. N. McIntyre, Columbus, Ohio; Research Committee, Dr. C. W. Leggatt, Ottawa, Canada; Cooperative Service Committee, Mr. W. O. Whitcomb, Bozeman, Montana. Dr. Willard Crosier, Geneva, New York, was appointed editor of the News Letter.

Complying with action taken by the Association in 1937, copies of the resolutions passed by the Association were distributed to parties in interest. The proposed Uniform State Vegetable Seed Law was forwarded to the secretaries and commissioners of agriculture, State seed analysts, seed journals, and to members of the legislative committee of the American Seed Trade Association. A statement relative to the Uniform State Vegetable Seed Law and the resolution relative to Federal seed legislation were given to the press. The Secretary of Agriculture advised on October 7, 1937, that a copy of the proposed Uniform State Vegetable Seed Law and the resolution relative to Federal seed legislation, which had been submitted to him, were referred to the Department's committee on seed policy.

The Association's greetings were extended to K. Dorph-Petersen, late president of the International Seed Testing Association. Through the News Letter the Association learned with sorrow of his subsequent death.

A full transcript of the discussions at the 1937 meeting was prepared and distributed to members of the Association, to commercial analysts, and to contributors at that meeting. It will be recalled that a general and much shorter report was made following the 1936 meeting. The extended report prepared after the 1937 meeting was with the purpose of avoiding the difficulty of making unbiased interpretations of the discussions and to give a full report to those unable to attend the meetings. It would be helpful to have the views of the members as to whether or not such a venture seems worthwhile.

There has been action at recent meetings to have the minutes approved each day as the meetings progress. The purpose is no doubt to effect an accurate statement of the progress of the meetings. It is extremely difficult for the secretary to prepare the minutes as the meeting progresses in a form suitable for adoption and publication. If all motions are submitted in writing it is suggested it may be more advisable were the minutes submitted to the executive committee for approval after the meetings but prior to publication in the Proceedings or elsewhere.

It continues to be difficult to obtain the papers presented at the meetings for publication at an early date. It is desirable to have all reports and papers in final form before the end of the meeting so that they may be acted upon in the form in which they will be presented for publication. It is desirable that committee reports have the declared approval of all members of the committee.- W. A. Davidson, Secretary.

REPORT OF THE AUDITING COMMITTEE

August 16, 1937, to June 15, 1938, Inclusive.

Balance as of August 16, 1937		$2090.16
Receipts:		
Laboratory dues	$ 500.00	
Proceedings	163.00	
News Letter	37.00	
Accrued interest	8.93	
	708.93	
		$2,799.09

Disbursements:		
Proceedings 1930-33	$ 711.64	
Proceedings 1937	654.45	
News Letter supplies	4.25	
Stationery	23.00	
Postage	101.30	
Dues Int. Seed Testing Assoc	50.00	
Reporter, 1937 meeting	10.00	
Programs, 1937 meeting	8.00	
Entertainers' dinners, 1937 banquet	4.90	
Desk set for Mr. Hillman	8.00	
Bonding of Treasurer	5.00	
Secretary's journal	1.50	
Envelopes for old Proceedings	4.00	
	$1,586.04	
	1,213.05	
		$2,799.09

(Signed) F. A. McLaughlin
(Signed) B. F. Forward

REPORT OF THE EXECUTIVE COMMITTEE

The executive committee met on June 20, 1938. All members were present except Mr. J. W. Zahnley. The committee recommends:

1. That abstracts or complete papers be submitted to the program committee prior to the annual meeting.

2. That all reports and papers be in final form and handed to the secretary before the end of the meetings.

3. That all motions be submitted in writing.

4. That the minutes be approved by the executive committee prior to publication in the Proceedings or elsewhere.

5. That the Secretary-Treasurer be authorized to pay the research committee members and the editor of the News Letter for necessary postage and other items of expense in connection with the work of that committee and the News Letter.

6. That favorable action be taken on the question of setting up qualifications for membership in the Association.

The canvass of the ballots showed the election of Dr. R. H. Porter - Vice-President, and W. A. Davidson - Secretary-Treasurer. Mr. L. N. Allen automatically becomes President for the coming year. -Emma F. Sirrine, Chairman.

REPORT OF COMMITTEE ON INTERNATIONAL SEED TESTING CONGRESS

As you know from the announcement made at the last meeting of this Association, the International Seed Testing Association decided to meet in the United States in 1940. It is now the pleasure of your Committee to report that the Congress of the United States has passed the House Joint Resolution 567, authorizing and requesting the President of the United States to invite the International Seed Testing Association to hold its Ninth Congress in the United States in 1940 and to invite foreign countries to participate in that Congress, and also provides for participation by the United States in that Congress. These invitations will be issued in due time, and it is our hope that international conditions will not be such as to prevent that Association from meeting in North America as planned. -E. Brown, Chairman.

PRESIDENTIAL ADDRESS

The Training of Beginners in Purity Analysis

Emma F. Sirrine
Division of Seed Investigations
United States Department of Agriculture
Washington, D.C.

This meeting of the Association of Official Seed Analysts of North America marks the 30th anniversary of the Association.

As I look back over the years, I realize that much has been accomplished by this organization, and that there still remains much for us to do in the years to come.

I had been with the Federal Government approximately three years when the organization came into being; during this 33-year period, more than 50 analysts have been appointed and trained in purity work in the Federal Laboratory, besides many others who have come for summer school work and special training.

It is upon this work, done under my supervision, that I base the following remarks: "The training of beginners in purity analysis."

It has been my observation that no one definite rule for training beginners applies to all individuals that undertake the work of purity analysis of seeds. To state that there is a definite technique to teaching seed analysis is more or less misleading. While the fundamental procedure is the same for all, the approach varies with different individuals.

It has been my general plan to start by telling beginners something of what it is all about; to lead them to realize that the work done in the purity laboratory has, like a pebble dropped into a pool of water, an ever-broading influence upon crops, upon agriculture, and upon mankind; that we are bending our efforts toward an education that is far-reaching in its effects: that through our efforts in the past years we have saved the farmer thousands of dollars and helped agriculture in an inestimable degree; that there is still much to be accomplished, and that we are all an integral part in the work to be done. This helps to make the dull routine of seed testing a little more inspiring.

It is necessary to impress upon beginners that extreme care must be exercised at all times in the work, and that each step in making a purity analysis must be taken with care and exactness or the labor involved in the other steps will be largely wasted through inaccurate results. This responsibility begins when we start mixing the sample to be analyzed. Show them that there is a right method and a wrong method of running a bulk sample through a mechanical divider, and that if this bulk sample is not carefully and thoroughly mixed, the foundation for error in the analysis is made and no matter how carefully the working sample is separated after being mixed, the error of sampling cannot be eliminated from the final results. Hence, the initial start is most important.

After the sample is carefully mixed, we take all of the seed from the last mixing for the purity analysis, weighing to three decimal places, and record the weight. We consider it bad practice and defeating the purpose of a mixing and dividing machine to take from and add to the sample obtained by mixing, so never permit a beginner to do this. If the sample mixed is smaller than an amount corresponding satisfactorily to that prescribed in the Rules and Recommendations for

Seed Testing, the sample should be mixed again and another small mixed portion added to the first sample taken. After the sample is separated, all portions are weighed (not a part of them weighed and then substracted from the original weight to get the weight of the other part). We consider it a double check to weigh each of the separations of a sample. Then, if a large variation in the original and final weighing does occur, the mistake is obvious; either an error has been made in reading the weighings, or the analyst has lost material in handling the sample. The practice of weighing the small quantities and subtracting from the original weight to ascertain the weight of the pure seed (or other quantity) has always been frowned upon by the Federal laboratories. If the final weight shows an unreasonable variation from the original weight, this sample is discarded and another sample drawn from the bulk for a new analysis. In figuring percentages, we figure to two decimal places, raising the largest remainder or remainders to bring the total to 100 percent.

One lesson or more is required in giving beginners careful instructions on how to use a delicate balance; not necessarily how to use the weights, but how to release the pans and how to handle the entire mechanism, without injury to any part. It is surprising how many college students that come into the laboratory do not seem to be at all familiar with the proper handling of delicate balances. They do not appear to realize that the scales should be absolutely in balance before starting to weigh, and many other minor details. Sometimes, we feel almost apologetic in cautioning them regarding details that they should know, and yet, I have found that these details are quite necessary.

Another important step is to teach the beginner how to use a lens. Very few beginners know how to use a lens with the least strain to the eyes. A lens having a magnification of 6X or 7X should be held as closely to the eye as is possible, and then the object brought into focus by moving the head and lens together, not by lowering and raising the lens only. If the eye is twelve inches or more from the lens, one may see a larger object but the definition is not good and one soon is conscious of eye strain. Do not hold a lens on an angle. Bring the eye and lens directly over the object to be examined.

To aid in obviating eye strain and to help train analysts to better know seeds, I always encourage them to go over a sample the first time without a lens. Many foreign seeds and practically all inert matter can be seen with the naked eye, and it gives a much better general idea of what a sample of seed looks like to work without a lens. Then go over the entire sample with a lens to remove all seed similar in appearance, and anything that may have been overlooked the first time. I believe it rests the eyes to follow this procedure. Some analysts get so wedded to their lens that they can hardly see seeds without it. This seems to me to be hard on the eyes, and makes the analyst so dependent upon a lens that he is quite helpless without one.

After a sample of seed has been mixed and weighed, the actual separating into component parts begins. It seems advisable to start beginners on what are considered easy samples, such as timothy or red clover seed, and let them first acquire a definite idea of what the pure seed in a sample looks like. Give them a mental picture, through a word description, supplemented with drawings, of the pure seed in question, and encourage them in removing all seeds that do not fit in with this picture. Then, if they have taken out some pure seed, and they doubtless have done so, review the picture with them and point out variations that occur in seeds of the same species. When they have finally established in their mind's eye what a sample of red clover seed, for example, looks like, differences in

seeds similar in appearance will stand out more clearly.

Do not start beginners on mixtures; it is confusing to realize that different seeds look so much alike, and differences that are quite apparent to one familiar with seeds are not at all outstanding to the beginner.

Never begin by telling analysts a great number of things. I believe it better to explain details as they develop in the analyzing of a sample. It adds zest to an analyst's work to find out things for himself, and he will do this through a little judicious guidance. While botanical knowledge is very essential for a good analyst, sometimes some very non-botanical comparisons fasten differences in seeds more firmly in one's mind than the most elaborate botanical explanation could possibly do. For example, I have had analysts tell me after twenty years they have never forgotten that I told them that black medick has a "little nose" and alfalfa seed does not. Had I gone into a lengthy botanical explanation of the reason why these two seeds are different, the difference probably would not have been as clear cut as was the "little nose" comment.

The two most difficult stumbling blocks for the beginner (and others) in separating inert matter from pure seed is to decide when a seed is half a seed and when it is more than half a seed, and whether the glumes of some grasses are empty or whether they have a small caryopsis. In regard to the last-mentioned problem, we have not found the dark chamber of much aid in analyzing some grass seed samples. In examining seeds under transmitted light, we have taken that portion of a sample that cannot be separated by the blower and selected seeds that appeared dark under transmitted light, but when these have been opened on the working board, the dark appearance is frequently found to be stamens, so our general procedure in grasses is to press the glumes with the forefinger of the left hand or press gently with the forceps. Sometimes there is a caryopsis that is broken by this method, but inasmuch as these broken caryopses apparently have no embryo, it seems to me that one does not go far astray to consider them as inert.

In deciding whether a broken seed is one-half size or less or more than one-half size requires, besides a general conception of variation in sizes of seeds, some of the philosophy that Mr. Brown so generously hands out whenever asked what to do in especially vexing problems, namely, "A little judgment should be used even in such cases." A beginning analyst may need guidance for a time in determining whether a seed is half or more, but in time problems such as this one become a matter of good judgment rather than an arbitrary decision set up by a supervisor.

The identification of foreign seed found in samples is the most pleasant part of a purity test and lends some variation to the routine analyzing. We use the drawings by Hillman and Henry as a guide to the identification of seeds. These are supplemented by examinations of the seeds themselves from the seed collection. A short talk on characters that separate seeds into families is the first introduction to seed identification. If family characters of seeds are pointed out to beginners, they can very soon locate the plate on which the seed or a similar seed is illustrated, and thereby get the genus if they cannot determine the species of the seed in question. Cross sections of seeds that show different embryo or cotyledon arrangement are urged. Some beginners find considerable difficulty in remembering after sectioning a Rumex or a Polygonum where the embryo is located in each, and here again a non-botanical suggestion helps, namely, "Polygonum is a longer word than Rumex - angle is a longer word than side - the two long words belong together."

While it is rather an easy matter for one to suggest new methods for conducting analyses that will shorten and expedite the tedious routine of purity work, and while these new suggestions may work out beautifully in theory, when they are put into practice they do not prove as constant as do the old tried methods. Therefore, in introducing new analysts to the work, I do not encourage any departure from the old regime. After they get the basic principles well inculcated, they are encouraged to try new methods to compare with the old; however, the technique of purity analysis established by analysts throughout the country has been altered but very little in the years I have been teaching beginners purity work.

A principal essential, it seems to me, is to instill ideals regarding the ultimate object of seed testing into the minds of the analysts. Just to do one test after another, with not much time on the side for research, becomes rather a monotonous procedure unless each worker can be made to feel that he is helping toward an ideal of improving plant culture and of being of service to others in bringing about higher standards of agriculture. Let the viewpoint of their work be striving toward an ideal for better seeds, better crops, and better production in agriculture for all. Ideals such as these lead the workers to broaden the foundation of seed testing, and makes them feel that the services they are giving fit the needs of those they are serving.

REPORT OF RESEARCH COMMITTEE
1937 - 1938

The activities of the Research Committee for the year 1937-1938 were similar to those of the previous year in that the major portion of the referee testing was conducted by regions. Six new sub-committees were organized to study specific problems which include (a) investigation of techniques for analysis of blue grass, (b) study of pathological aspects of seed testing, (c) germination of injured weed seeds, (d) analysis of brome grass seed, (e) use of sand as a substratum for germination tests, and (f) value of hard seeds.

The names of the regional chairmen are as follows, together with the year in which their period of present appointment expires:

W. O. Whitcomb	Region No. 1	1939
R. H. Porter	Region No. 2	1941
C. W. Leggatt	Region No. 3	1940
W. L. Goss	Region No. 4	1942
C. M. Bass	Region No. 5	1938

The report is divided into four parts: (a) referee tests conducted by regional chairmen, (b) referee tests for the Association as a whole, (c) report of sub-committees, and (d) recommendations.

Report for Region No. 1
W. O. Whitcomb

Germination testing was emphasized during the past year in the referee testing work in Region No. 1. This region was composed of the Provinces of British Columbia, Saskatchewan, and Alberta; and the States of Oregon, Washington, Idaho, Montana, Wyoming, North Dakota, and South Dakota. The laboratory in British Columbia was established this year and was not sufficiently equipped to do the referee work, while the laboratories of Oregon, South Dakota, and Wyoming did not feel that they could undertake the work because of limited help and the pressure of routine work. The other six laboratories took part in the work and cooperated closely. Two seed trade laboratories also took an active part in the work.

Plan of Work - The germination work was so planned that each laboratory could test each lot of seed by four methods and in addition any special method might be chosen. The four prescribed methods were (1) soil, (2) sand, (3) half sand and half soil, and (4) blotters for the sweet clover and alfalfa and paper towels for the oats and peas. Special lots of sand and soil were sent to each laboratory from the Montana laboratory, and instructions were given for treating with formaldehyde for sterilizing. This sand was a fine river sand which contained some organic matter and hence proved to be rather unsatisfactory in some cases. It is apparent that for future work of this kind a coarser sand should be used. The special tests, in addition to those listed above, which were made by the various analysts were interesting and varied. A number used a coarse sand which was unsterilized.

Seeds Tested - Five lots of seeds, all of which showed some peculiarities in germination testing, were studied.

1. Sweet clover - Rather low germination and some weak and broken sprouts.
2. Alfalfa - Rather low germination and some weak and broken sprouts.
3. Alfalfa - Two state laboratories differed in germination.
4. Oats - Irregularity in germination results.
5. Peas - Low germination.

Due to the limited time available for the referee testing this year, the plan of making retests by those analysts who found their results at variance with others as tabulated, was not carried out. However, tabulated results were reported back to the participating analysts soon after the receipt of results on each sample. Good use was made of these tabulations, as was evidenced by the replies which were received from some of the analysts.

TABLE 1

GERMINATION RESULTS BY DIFFERENT METHODS BY THE VARIOUS LABORATORIES

Lab. No.	Soil	Sand	½ Sand and ½ Soil	Blotter or paper towels (1)	Special method
	%	%	%	%	%
	1. Sweet Clover				
2	69	60	69	63	69
3	63	--	--	60	67
5	80	--	81	77	79
6	69	43	67	77	71
7	71	69	71	66	71
8	63	60	57	62	--
10	70	59	69	70	70
11	--	--	--	71	68
Range	17	26	24	17	12
	2. Alfalfa				
2	70	70	66	67	62
3	66	60	62	63	70
5	79	80	81	80	72
6	76	51	71	73	72
7	76	72	79	74	74
8	64	66	69	66	--
10	74	67	69	67	--
11	66	56	60	71	61
Range	15	29	21	17	13
	4. Oats				
2	84	85	86	84	82
3	88	90	88	87	84
5	50	69	--	79	82
6	89	90	90	81	85
7	89	87	86	82	--
8	84	81	82	82	81
10	--	--	--	89	90
11	88	85	87	83	--
Range	39	21	8	10	9
	5. Peas				
2	62	55	58	53	--
3	56	60	56	62	54
5	--	47	--	55	53
6	50	58	54	62	58
7	62	54	51	54	--
8	46	--	55	51	--
10	--	--	--	57	58
11	--	--	--	55	49
Range	16	13	7	11	9

(1) Paper towels used for oats and peas except laboratory 11 for oats.

Results - The detailed reports which were made to the participating analysts gave each an opportunity to check his results with those of each other laboratory as to strong sprouts, weak and broken sprouts, dead seed, and hard seed. While it is not practicable to give these details in this report, average results are given as an indication of how the various methods responded in the hands of the various analysts for the seeds under consideration. These average results are given in Table 1.

Sample No. 3, which was the lot of alfalfa on which a difference in germination plus hard seeds of 10% between two state laboratories was observed by a dealer, proved to be of considerable interest. The range in results of tests by the blotter method as made by eight analysts was as follows: Germination, 12%; hard seeds, 6%; and total germination plus hard seeds, 10%. This is apparently a greater difference than there should be on this type of seed. Studies of this kind are of special value.

A number of the analysts expressed considerable interest in continuing the work with peas and some of the other large seeded legumes which sometimes present certain problems in testing.

Report for Region No. 2
R. H. Porter

A study of reports of referee tests for the past several years indicates that one of the most important problems in seed analysis is to determine specific causes for lack of uniformity of results as obtained by both commercial and official analysts. The referee tests in Region No. 2 were, therefore, selected with the objective of determining, if possible, what specific factors were operating to account for greater differences than could be accounted for on the basis of probability.

Redtop and orchard grass seed were selected for these tests because extreme differences in both purity and germination frequently occur. All of the 11 official laboratories and four commercial analysts in Region No. 2, and the U. S. Department of Agriculture laboratory in Washington cooperated in the first referee tests. The specific objectives which led to a study of redtop seed are as follows:

1. To investigate the possibilities of using half-gram samples (one gram of pure seed contains 11,000 seeds) for purity analysis.
2. To determine the degree of uniformity of separations by different analysts.
3. To determine if results within the range of natural variability can be expected when one analyst checks the fractions from several sub-samples drawn from the same lot.
4. To study methods of germination of redtop seed and determine reasons for extreme differences, if such occur.

The procedure used was to send each laboratory two sub-samples (Nearly one-half gram in weight), the two obtained by sub-division of approximately one gram drawn by the Boerner sampler. Each analyst was requested to make the separations, calculate percentages, and send the fractions to Miss Clara Fuhr at Columbia, Mo., who kindly consented to check each fraction, remove any particles which she considered improperly classified, and return same to each analyst for recalculation. From one of the pure seed fractions, each analyst removed enough seed for a germination test (4 x 100 seeds) by two methods. The other pure seed fraction was

TABLE 2

SUMMARY OF REDTOP REFEREE TEST. - 1 9 3 7

Laboratory No.	Purity results with half normal weight of sample: Original, percent — Pure Seed	Crop Seed	Weed Seed	Inert	Mean purity before correction	Corrected (1), percent — Pure Seed	Crop Seed	Weed Seed	Inert	Mean of duplicates as corrected, percent — Pure Seed	Crop Seed	Weed Seed	Inert	Germination percent — Your method	Uniform method
1	88.1	.4	2.5	9.0		88.4	.4	2.3	8.9						
	87.8	1.0	2.4	8.8	88.0	88.2	1.0	2.5	8.4	88.3	.7	2.4	8.6	95	91
2	87.9	.7	2.2	9.2		(2)									
	88.5	.4	1.9	9.2	88.2					88.2	.6	2.1	9.2	86	87
3	89.5	.4	2.8	7.4		88.6	.8	2.5	8.0						
	89.2	.6	2.2	8.1	89.3	88.4	1.0	2.2	8.5	88.5	.9	2.3	8.2	95	93
3,2	87.9	.8	2.9	8.4		87.8	.8	2.9	8.5						
	88.7	.6	2.5	8.2	88.3	88.6	.6	2.5	8.3	88.2	.7	2.7	8.4		
4	88.6	.9	3.3	7.3		88.2	.7	2.9	8.3						
	87.7	.8	3.9	7.5	88.2	88.3	.6	2.7	8.4	88.0	.7	2.8	8.5	93	93
5	87.3	.8	2.6	9.3		87.5	.6	2.5	9.3						
	88.3	.9	2.4	8.4	87.8	88.7	.7	1.8	8.8	88.1	.6	2.2	9.1	92	96
6	86.6	.9	3.2	9.4		87.0	.6	2.8	9.6						
	86.9	1.0	2.9	9.2	86.8	86.2	1.4	3.1	9.4	86.6	1.0	2.9	9.5	86	88
7	88.2	.6	2.4	8.7		(3)									
	88.2	.7	2.6	8.6	88.2					88.2	.6	2.5	8.7	89	91
8	86.2	1.1	3.1	9.7		85.7	1.4	3.0	10.0						
	87.8	1.0	2.9	8.3	86.9	88.6	1.1	2.6	7.8	86.9	1.4	2.8	8.9	91	93
9	88.3	.6	2.3	8.7		(4)									
	88.8	.5	2.5	8.3	88.5									96	95
10	85.0	.8	3.3	11.0		85.9	.8	2.7	10.7						
	85.1	.8	3.6	10.6	85.1	85.6	.8	3.0	10.6	35.7	.8	2.9	10.6	91	90
11	87.2	2.1	2.3	8.4		(4)									
	89.3	1.0	2.0	7.8	88.3										
12	88.2	.9	2.2	8.8		(2)									
	88.5	.6	2.4	8.5	88.3					88.3	.7	2.3	8.6	92	87
13	87.0	1.0	3.1	8.9		(5)									
	87.7	.6	2.8	8.9	87.3					87.3	.8	3.1	8.8	93	92
14	88.2	.6	2.2	9.0		(5)									
	88.4	.4	2.2	9.1	88.3					88.3	.5	2.2	9.0	91	89
15	87.9	.8	2.5	8.8		87.7	1.0	2.5	8.9						
	87.4	.8	2.6	9.3	87.7	87.3	.9	2.5	9.3	87.5	.9	2.5	9.1	92	94
16	89.2	.6	2.3	7.9		88.8	.6	2.3	8.3						
	89.2	.2	2.2	8.4	89.2	88.8	.2	2.2	8.7	88.8	.4	2.3	8.5	91	90
Mean					87.9					87.8	.8	2.5	8.9	91	91
X^2					155.24					128.62				61.62	54.02
P					<.01					<.01				<.01	<.01
Mean weight of sample	.488g.				.976 g.	.488 g.				.976 g.					

(1) Separations checked and corrected by Miss Fuhr.
(2) No corrections made.
(3) Original made by Miss Fuhr.
(4) Weights not included in report.
(5) Corrections too small to be significant.

returned, in most cases, to the Iowa Laboratory.

The tabulated results of the tests made by 16 laboratories are presented in Table 2 and the discussion by the regional chairman follows.

Discussion of purity results with redtop.

The intention was to send each analyst two half-gram samples. The required amount of bulk seed was obtained, then sub-divided until sub-samples approximately one gram in weight were obtained, each of which was again sub-divided and the duplicates from each final separation kept together; in other words, each analyst received a one gram sample divided once. The mean weight of sample was 0.488 grams or 0.976 grams for each initial sample which was sub-divided into a pair. The heaviest weight of pairs was 1.054 grams, the lightest 0.868 grams, the heaviest working sample 0.554 grams and the lightest 0.413 grams. Two pairs of samples were tested by the Iowa laboratory primarily for the purpose of checking on how nearly the analyst could duplicate Miss Fuhr's technique.

In the first four columns of Table 2 will be found the purities of half-gram samples before any corrections were made. In checking for uniformity, the chi-square test was used because all samples were drawn from the same small lot in our laboratory. When two half-gram samples of redtop are used from the same lot, whose purity is close to 88%, the difference should not exceed 1.3 if the samples are truly representative of a homogeneous sample. By reference to the first column, it will be noted that two laboratories, Nos. 8 and 11, obtained differences greater than 1.3. Either the sampler did not operate uniformly in dividing the one-gram samples into half-gram fractions, or the analyses were not uniform. There is a strong indication that the sampler was at fault because after corrections were made for No. 8, the difference was 2.49. Lack of data for corrected purities of laboratory No. 11 prevents any complete interpretation.

In column 5, will be found the purities obtained by each laboratory on the basis of the duplicate sub-samples considered as one sample (nearly one gram). The figure given is the weighted mean and is theoretically what would have been obtained if the initial one-gram sample had been analysed without additional sub-division. By comparing the 17 purities in column 5 by the chi-square method, the value is high and the probability far below 1%. The interpretation is one of three or all: (1) incorrect analysis (2) improperly mixed bulk lot, or (3) non-representative one-gram sub-samples. If two representative sub-samples, one gram each in weight, are drawn from a thoroughly mixed lot of redtop, whose purity is about 88%, the difference should not be more than 0.85. The lowest figure in column 5 is 85.1 and the highest is 89.3, a difference of 4.3%. Part of the variation is caused by errors in analysis, but not all, as will be shown later. The present tolerance formula of the Association of Official Seed Analysts would allow 2.6%, which is far too much for redtop and its use prevents a proper study of the causes of variation in seed analyses.

In columns 6, 7, 8, and 9 will be found the corrected purities whenever any transfers were made by the referees, provided each analyst made the necessary corrections. A study of the purities (by pairs) in column 6 shows that only laboratory 8 had a difference greater than 1.3, the allowable difference when half-gram samples of redtop are used. The possible cause of this was mentioned previously.

In columns 10, 11, 12, and 13 will be found the percentages resulting from

treating each pair of duplicates as a unit after corrections were made by the referee. The chi-square value is less than that for the uncorrected purities, indicating less variability (difference in extremes = 3.04), but the probability is still far below 1%. The conclusion which seems logical is that the sampler did not furnish representative sub-samples. With representative one-gram samples, the purities should all have fallen (basis of corrections) between 87.6 and 88.5%.

The data suggest that half-gram samples properly drawn from thoroughly mixed samples may be expected to supply reasonably accurate results as to percentage of pure redtop. If the analyst is in doubt, a second half-gram sample should be tested and the average used. The time required for a half-gram sample is slightly more than half that for a gram sample and since fatigue frequently is a factor in analysis of redtop, the smaller sample might well be an aid to greater accuracy. More study of the use of smaller samples is needed.

A second point worthy of mention is the disposition of species of Agrostis other than A. alba. It is reported that a few state laboratories do not permit the inclusion of A. elliottiana in the pure seed. According to the rules, such foreign seeds should be removed. If half-gram samples were used, it would be less difficult to remove such seeds.

A third point is the disposition of diseased seeds. Smutted florets are not usually difficult to detect, but the degree of infection with Claviceps purpurea, which causes ergot, is variable and our interpretation is likely to be variable concerning infection. The suggestion is that we remove plainly ergotized grain. It may be possible to standardize the procedure by the use of controlled air pressure.

Comments by Miss Fuhr who checked the separations are given below.

"On the whole, I think the tests were very well done, much better than I anticipated, the differences in procedure being the most significant.

"The chief divergencies in procedure were with respect to the following:

"Agrostis elliottiana: Five official laboratories and two commercial laboratories left the A. elliottiana in the pure seed, but only one mentioned its presence; while three official laboratories and three commercial laboratories put A. elliottiana in the weeds, and one official laboratory put these seeds in the crop seed.

"If only a small number of these seeds are present in redtop, as is usually the case, it is probably unimportant that the amount be given. I do not know whether seedsmen consider the presence of A. elliottiana in an amount of several percent harmful. If it causes the redtop to be inferior, I do think the amount of A. elliottiana present should be given whether left in the pure seed or placed in the weeds.

"Diseased seeds: One laboratory left all the diseased seed in the pure seed and the other 13 left in only a few of the heavy diseased seeds. These seeds were mostly affected by smut. Such heavy diseased seeds are not so easily detected, unless one looks very carefully. I believe there are usually a few of the heavy diseased seeds which the blower does not remove and which have to be removed with forceps.

"Black three-cornered material: Five official laboratories and one commercial laboratory put this material in the weed seeds with various identifications, while four official laboratories and four commercial laboratories put it in the inert. It appears that this may be a point for controversy. I have had this material sent to us a number of times this fall by seed companies asking for identification. I do not believe we can be certain enough about most of it.

When sectioning it, it usually crumbles to pieces and none of it appears to have an embryo. We have always thought that this material was probably undeveloped Rumex and have always placed it in the inert.

"Puffy Achilles seeds: A few analysts put these in the weed seeds. We believe that they contain a larva and therefore put them in the inert.

"I believe it is possible and desirable for the official analysts to use the same procedure in their purity analysis work. Since some no doubt will not agree with our procedure, perhaps the points in question should be further discussed, now that the lack of uniformity, at least in redtop tests, has been brought to everyone's attention. A small number of bluegrass seeds, without the glumes, are almost always present in redtop. Most of the analysts left either all or part of these in the pure seed. I believe that such fine material as is included in redtop separations should be placed in glass vials rather than envelopes. In a number of cases part of the material was lost because the envelope had an unsealed corner. I think it is the best procedure to require scientific names in making crop and weed seed identifications on referee tests. Common names are very indefinite quantities, at best, and are apt to be very confusing."

Discussion of germination tests with redtop.

The germination results are also shown in Table 2, in which a uniform method (petri dishes and filter paper) is compared with the method used by each laboratory. The number of normal seedlings obtained in each member of the quadruplicate tests, as reported by each laboratory, was reasonably uniform, hence chi-square values were not computed. The chi-square and probability values obtained by comparing the 16 tests for each method are given in Table 2 and, although there is greater lack of uniformity than should be expected from uniform pure

TABLE 3.
SUMMARY OF GERMINATION TESTS OF REDTOP, SUB-SAMPLES "B"

Laboratory No.	Sub-sample a Laboratory's own method	Sub-sample b Tested in Iowa Laboratory	Difference	
			Amount	Significant
	%	%		
1	96	94	1	-
3	95	95	0	-
4	93	93	0	-
6	86 (88) 1.	97	11	P = <.01
7	89 (91) 1.	94	4	P = .035
8	91 (93) 1.	94	3	P = .09
10	91	93	2	-
12	92	95	3	-
13	93	91	2	-
14	91	92	1	-
15	92	92	0	-
16	91	90	1	-
Total	1100	1120		
Mean	92	93		
X^2	30.55	22.44		
P	<.01	.02 +		

1. Germination obtained by each laboratory using petri dishes and filter paper.

Comparison of totals: 4469 sprouts by Iowa method
4392 sprouts by own method

$X^2 = 8 +$
P = <.01 (a significant difference)

seed fractions, the uniform method gave a lower chi-square and less variation than when each laboratory used its own method.

The pure seed fractions of sub-sample "b" as returned by each of 12 analysts were germinated in the Iowa Laboratory under as nearly uniform conditions as could be provided. The results are given in Table 3, together with the germination as obtained by each laboratory on sub-sample "a", using the method preferred by the laboratory. In two cases out of 12, the differences between the Iowa test and the cooperating laboratory were significant.

The probability resulting from a comparison of the germination of the 12 pure seed fractions by a uniform method in the Iowa Laboratory is shown to be 0.02+, indicating either slight lack of uniform pure seed fractions or other unexplainable errors. In general, it may be concluded that the pure seed fractions as checked and corrected by the referee were as uniform as is humanly possible to make them.

Tests with orchard grass seed

More variation in weight of sample was noted with the orchard grass tests than with redtop. The mean weight of the working samples was 0.911 grams, while that of the pairs treated as one sample was 1.822 grams. The lightest weight of a pair was 1.188 grams, the heaviest 2.180 grams, the lightest working sample 0.590 grams, and the heaviest 1.130 grams. The divider did not deliver samples of uniform weight.

The arrangement of the data by columns in Table 4 is the same as for redtop. Attention is called to the pairs in column 1. On the basis of one-gram samples of orchard grass representative of a given lot whose purity is about 85%, the allowable difference for a 5% probability is about 3.0%, and in no case does the difference in duplicate purities (uncorrected) equal 3.0%. In column 6, however, laboratory No. 4 shows a difference of 3.6. Since this figure is from a corrected purity, the assumption is that either the samples were not homogeneous or the error in reweighing was possibly enough to cause a difference of more than 3%.

In columns 10, 11, 12, and 13, are given the percentages based on each pair used as one entity, hence the mean weight per sample is nearly two grams (1.822). The purities in column 10 were compared by the chi-square test and the probability is 0.013, indicating results too variable but much less than in column 5. The corrections reduced the variability markedly, but even after the corrections, the variation is too great. If two representative sub-samples (each two grams) be drawn from a homogeneous lot the allowable difference is 2.1% (based on 5% probability). Again, the logical conclusion is that the sampler did not divide uniformly. The range in this sample (using two grams for each analysis) should be about 84.0 to 86.2%.

In this connection, the Iowa Laboratory drew five sub-samples weighing about two grams each, tested them by the modified method described last summer, and the mean purity was 85.2. range 84.3 to 85.8. The probability was slightly more than 50%.

Apparently it is best to use a two-gram sample which is as representative as possible. It should not be drawn until the bulk lot is thoroughly mixed. The Boerner sampler does not always divide uniformly, and this deficiency is greater with orchard grass than with most other seeds.

The comments made by Miss Schulte who checked the separations are as follows:

"We received 13 samples and ours makes 14 in all. They ranged from 82 to

TABLE 4
SUMMARY OF ORCHARD GRASS REFEREE TEST. - 1 9 3 7

Laboratory No.	Purity results with half normal weight of sample: Original, percent: Pure Seed	Crop Seed	Weed Seed	Inert	Mean purity before correction	Corrected (1), percent: Pure Seed	Crop Seed	Weed Seed	Inert	Mean of duplicates as corrected, percent: Pure Seed	Crop Seed	Weed Seed	Inert	Germination percent: Your method	Uniform method
1	84.4	1.0	.6	13.9		84.4	1.2	.6	13.8						
	85.0	1.2	.3	13.6	84.7	85.1	1.2	.3	13.4	84.8	1.2	.5	13.6	87	88
2	86.3	.6	.3	12.8		(2)									
	84.2	1.1	.2	14.5	85.3					85.3	.8	.3	13.6	91	88
3	83.7	.9	.6	14.8		85.2	.8	.6	13.4						
	86.0	.9	.3	12.9	84.9	86.2	1.0	.3	12.5	85.7	.9	.5	12.9	95	90
4	83.0	1.6	.1	15.4		82.3	1.1	.7	16.0						
	85.8	1.3	.1	12.8	84.2	85.8	.9	.1	13.2	83.9	1.0	.4	14.8	88	89
5	88.6	.9	.1	10.4		85.0	.9	.1	14.0						
	88.3	.9	.4	10.4	88.5	85.2	.9	.4	13.6	85.1	.9	.2	13.8	90	92
6	82.9	1.2	.5	15.4		84.5	1.3	.7	13.6						
	83.8	1.1	.7	14.5	83.3	83.7	1.4	.9	13.9	84.1	1.4	.8	13.8	85	85
7	86.7	1.3	.4	11.5		86.5	1.3	.4	11.7						
	85.3	1.0	.2	13.6	86.0	85.1	1.0	.2	13.7	85.8	1.2	.3	12.8	89	88
8	83.1	1.9	.2	14.8		81.3	1.8	.2	16.7						
	82.0	.8	.2	17.0	82.6	82.7	.8	.2	16.3	82.0	1.3	.3	16.5	89	85
9	87.4	.9	.2	11.4		85.7	.9	.2	13.2						
	86.9	.7	.1	12.3	87.1	85.9	.7	.1	13.3	85.8	.8	.2	13.2	87	88
10	83.2	1.0	.5	15.4		84.0	.8	.5	14.7						
	82.9	1.0	.2	15.9	83.1	84.5	1.0	.2	14.2	84.3	.9	.3	14.5	89	85
11	82.1	.6	.6	16.8		(3)									
	80.9	.4	.3	18.4	81.5										
12	86.4	1.1	.5	12.1		(4)									
	86.7	1.1	.4	11.8	86.5					86.5	1.1	.5	11.9	85	86
13	87.0	.7	.1	12.2		86.4	.7	.1	12.8						
	86.8	.9	.2	12.1	86.9	85.6	.9	.2	13.3	86.0	.8	.2	13.1	92	92
14	85.6	1.0	.3	13.1		(5)									
	83.6	1.1	.1	15.2	84.6					84.6	1.0	.2	14.2	79	86
15	85.4	.8	.5	13.3		85.4	.8	.5	13.3						
	85.7	.9	.4	13.0	85.6	85.7	1.0	.4	12.9	85.6	.9	.5	13.1	83	85
16	86.5	1.0	.5	12.0		86.3	1.0	.5	12.2						
	84.4	1.2	.5	13.9	85.4	84.3	1.3	.5	13.9	85.3	1.1	.5	13.1	89	87
Mean					85.0					85.0	1.0	.4	13.7	88	87
X^2					304.62					28.28				74.79	29.89
P					<.01					.013				<.01	<.01
Mean weight of sample	.911 g.				1.822 g.	.911 g.				1.822 g.					

(1) Corrected by Miss Schulte.
(2) Original made by Miss Schulte.
(3) Weights of corrections not included in report.
(4) No corrections made by Miss Schulte.
(5) Corrections too small to be significant.

86% with the exception of one laboratory. This laboratory reported 88%, but the attached glumes were not removed. The samples we received were all fairly well done. I think the hardest part of the work is to know which immature caryopses to put into the inert and which into the pure seed. I suppose this will be a good topic for discussion at the meeting next year."

Discussion of germination of orchard grass.

Theoretically, the germination tests should have been uniform, because only seeds from corrected purities were used. It is believed that the samples used for germination were uniform, hence the differences are caused by differences in environment or substrata. The uniform method for orchard grass (Table 4) gave results much less variable (lower chi-square) than the method used by each laboratory, however, in both cases the probability is less than 5%. There is no doubt but that a more uniform technique is needed for the germination of orchard grass.

This type of referee test is not new, however no attempt has been made to rate any laboratory but rather to find out where the causes for variation lie, and help each analyst to improve in technique. We should be careful not to charge all wide differences to an analyst when the sample may not be representative, however, we should not charge all differences to causes other than ourselves. The only way we can improve and standardize our methods is to make an unbiased study of methods and finally adopt the one which gives the most uniform and accurate results.

Second Orchard Grass Referee Test
1937 - 1938

A second referee test with orchard grass was conducted by the analysts in Region No. 2 in May. Samples weighing approximately two grams were drawn and analyzed in the Iowa Laboratory by the modified method as described in the 1937 Proceedings. The heavy single florets were designated as portion "a" on which a germination test by two methods was requested, namely, on top of moist filter paper in petri dishes, and between blotters. The unseparated, heavy multiple florets were designated as portion "b" and each analyst was requested to make a separation by the official method and determine the percentage of inert material. The data obtained are recorded in Table 5.

The data obtained by germination of the single florets in portion "a" by 18 laboratories show that 10 reported slightly higher germination on top of blotters in petri dishes than between blotters, but the increase is probably not significant. When the highest percentage for each laboratory is used, the differences are not significant. Inasmuch as uniform pure seed fractions were provided, the results are encouraging and indicate that if a uniform method of purity is developed, reasonably close agreement in germination may be expected.

TABLE 5.
SUMMARY OF SECOND ORCHARD GRASS REFEREE TEST
REGION NO. 2, MAY, 1938.

Laboratory No.	Portion "a" Percentage germination					Portion "b"		
	Petri dish		Between blotters			Percentage inert in multiple florets	Time required (minutes)	
	14 days	18 days	14 days	18 days	Highest test		Separating	Weighing and checking
1	79 (1)		81 (1)		81	19.8	15	
2	83	84	82	83	84	18.5	26	
3	86	86	84	85	86	20.5	30	30
4	67	--	81	--	81	18.8	28	
5	87	87	82	82	87	--	--	
6	80	82	73	75	82	18.7	25	
7	82	83	79	81	82	19.4	30	
8	80	81	82	83	83	16.3 (3)	28	5
9	72	74	76	80	80	15.9 (3)	45	15
10	79	82	81	82	82	20.2	38	25
11	85 (2)	85	--	--	85	18.8	90	
12	80	81	79	80	81	19.9	20	
13	85	88	79	84	88	16.7	25	
14	80	83	75	78	83	17.8	35	
15	78	82	--	--	82	20.1	23	
16	83	--	86	--	83	21.1	17	
17	77 (2)	84	79 (2)	83	84	18.4	22	
18	84	84	83	83	84	21.0	36	
Mean	80	80	80	80	83	18.9	31.4	
X^2					22.33			
P					.17			

(1) Read in 15 days.
(2) Read in 10 days.
(3) Probably lower than should be expected from uniform samples.

Report for Region No. 3.
C. W. Leggatt

During the year five samples were distributed for referee tests to members of Region No. 3. Samples were also sent to the laboratory of the U. S. Department Agriculture at Washington, and to that of the Chairman of the Research Committee.

The work for the year is summarized in Table 6.

The work carried out in 1936-37 with beets and mangels indicated that there was a need for further study of the germination of Beta, and that possibly the sieve method of securing the seeds for germination would be the solution of the problem of uneven tests. Thus, the first sample issued was a Mangel, which the

TABLE 6.
SUMMARY OF REFEREE TESTS FOR REGION NO. 3, 1937-1938.

Sample No. and Kind	Number Laboratories	Purity Range	Purity Mean	Germination Method	Germination Range	Germination Mean
		%	%		%	%
1. Mangel	8	Not asked		8 x 50 balls taken at random	76 - 87	81
				400, using sieves	73 - 90	80
2. Parsnip	12	Not asked		8 x 50 between blotters	69 - 79	75
	9			8 x 50 on top of sand	62 - 79	73
	11			8 x 50 in sand	69 - 80	76
3. Cabbage	13	99.3- 99.7 (1)	99.5(1)	4 x 100 between blotters	57 - 70	63
				4 x 100 on top of blotters	53 - 72	63
				4 x 100 in sand	45 - 72	64
4. Onion	10	Not asked		4 x 100 between blotters	54 - 70	64
				4 x 100 in sand	58 - 69	63
5. Onion	10	Not asked		4 x 100 between blotters	41 - 54	47
				4 x 100 in sand	42 - 54	47

(1) One station not included, since only "round numbers" reported.
(2) Omitting one station having no experience with Brassica.

writer personally mixed and divided as carefully as his equipment would permit. Cooperators were requested, first to draw 8 x 60 balls at random as in the standard method, and then to separate the remainder (up to 50 g.), using sieves, into four size-groups from which 400 balls were to be taken in proportion as they occurred in each group.

The germination results secured, which could not be examined statistically by the chi-square method as originally intended owing to some of the laboratories not having followed directions rigidly, showed greater variability by the sieve method than by the standard method. A comparison of the 200-ball weights of the various size groups made by each laboratory showed that these were substantially similar; thus the laboratories were apparently using sieves that were quite comparable, but the proportions retained by these sieves varied sharply. It appeared that the wide ranges reported in Table 6 were largely due to the samples distributed not being strictly comparable. The figures showed a considerable positive correlation between ball weight and germination, which, in view of the above circumstances, would be sufficient to account for the greater variability shown by the sieve method.

In view of the above it seemed inadvisable to issue further samples of Beta spp. until we have the means of dividing and sampling a bulk properly.

I am much indebted to Messrs. Brown and Munn for certain observations on the subject of sampling Beta for germination. They have pointed out that a good deal of work has been done in the past to determine whether the sieve method has any special advantage which would really make it worth while to use such a slow method. The conclusion resulting from this study was that, provided the sample was mixed and divided to sub-samples approaching in size the number of balls required for a test by means of a suitable mechanical mixer, and that the balls for germination were counted therefrom either by hand, or better, by a vacuum counter, no advantage was secured by the sieve method.

The second sample sent out was one of Parsnip, which was issued at the special request of one of the laboratories. Three methods of germinating this species were compared: the standard method, between blotters; in sand; and on top of sand.

The results for normal sprouts by the standard method, between blotters, showed reasonably good concordance. A P-value of 0.05 was calculated, indicating that the differences in results might be held to represent random variations due to sampling. This is almost true also of the tests in sand, but on top of sand the variation was excessive. The conditions required for the tests made on top of sand were apparently difficult to control. This was particularly true of one laboratory, as indicated by their individual replicates.

The variation in interpretation of abnormal sprouts was, however, in all cases excessive. There seemed to be no sort of unanimity in this regard. It is probable that this is in part due to (1), lack of agreement as to whether certain very weak types of sprouts were to be counted as abnormal or included with dead seeds; and (2), lack of agreement as to whether sprouts should be counted as normal or not. It was, unfortunately, not possible to check this point.

A little further light may possibly be thrown on the relative merits of the different methods by taking a selected group of stations. Five stations were omitted for one or other of the following reasons:-

1. Because they were not equipped for proper sand tests.
2. Because they had evidently very poor control of their "top of sand tests", as evidenced by excessive variability in their replicates.
3. Because they had had no experience with parsnip.
4. Because they were unable to conduct the sand tests for various reasons.

Taking the remainder, the following data were calculated:-

Kind of Test	X^2	n	P
Between blotters	12.34	6	.05
Top of sand	7.88	6	.25
In sand	7.55	6	.28

This indicates that with stations which have been able to manage the sand tests properly, more uniform results have been secured with them than with the blotter tests. This does not imply proof that the sand tests were superior, but suggests that they are a useful adjunct to the regular test when the technique has been mastered; and indicates that sand is a satisfactory medium for the germination of parsnip. It should be mentioned, however, that one of these stations used a very sandy soil rather than pure sand.

The third sample was Cabbage, and called for both purity and germination. By an oversight, the germination tests were requested to be done at 18° - 20°C. instead of by the method in the new Rules - 10 days at 30°C. The results clearly indicate the fact that the old method, at least, did not give satisfactory results.

The purity results evidenced an unusually close agreement even for such a high purity sample. Also, the percentages of Brassica fragments showed that the samples suffered no injury in transit. The incidence of the few weed seeds that were observed was strictly in accordance with the Poisson Distribution. Thus we can conclude that the samples distributed were all adequately mixed and truly representative.

Unfortunately, a similar agreement was not in evidence in the germination tests. The best, that is, most concordant, results were obtained in the between-blotter tests counted at five days; but if all laboratories were working on a strictly uniform basis, a higher degree of uniformity should be evidenced than even these records showed. The value of P for the observed chi-square was 0.01, whereas it should have been not less than 0.05 for the results to have been considered reasonably uniform. In all other tests P was even smaller than this.

The germination trials in light brought about great difficulties in interpretation, probably because of lack of experience in germinating Brassica on top of the medium. Our own experience is that certain samples of Brassica respond to light, and that we must be prepared to use this method if necessary. Professor Munn observes that this is their standard method, and that they "Count the seed directly to the top of blotters which are left undisturbed for seven to eight days, when interpretation and reading for disease and counts are made. Tests may be continued longer if that is indicated. Germinators have high humidity and no reason for covering the seed and thus interfere with the normal growth response."

Most laboratories felt it necessary to prolong the tests beyond five days, but there is no doubt, it seems, that the attempt to give a five-day report confused the issue, and the "final" reports, which varied from 5 to 10 days, exhibit greater lack of uniformity than the five-day reports.

The sand tests were distinctly disappointing since here there was no question of a difference in time, and it is to be presumed that there was reasonable uniformity in temperature control. The differences in the results are not associated with differences in interpretation of abnormal sprouts. It would appear that lack of uniformity in conducting the test was the principal factor.

With regard to answers to certain specific questions, a good deal of difference of opinion existed.

Of the 13 laboratories taking part, eight reported that they preferred between-blotters to top-of-blotters, three reported in favour of top-of-blotters, one of which stated this was their regular method, and two refrained from comment. One laboratory was inexperienced with Brassica and found the top-of-blotter tests very confusing. Their results were obviously very far out.

There were wide differences in interpretation as to what seeds were to be considered "fresh" and "dead". However, bracketing these two classes together we have a class of "ungerminated seeds" about which there should be little question. Yet the chi-square test on "ungerminated seeds" gave a P value of about 10^{-9}, which indicates great lack of uniformity. Since we may here consider interpretation not to be a factor, we may conclude that it is very probable that there were considerable differences as between different laboratories in the

germination conditions to which the seeds were subjected.

Samples 4 and 5 were both Onion, and represented a continuation of the study of onion germination started last year. Tests were called for by the standard method and in sand. The sand was made up to contain 7% moisture, and the tests were run at 20°C. A special feature of these tests was an attempt to discover whether differences in interpretation hinged upon whether or not an "elbow was present. Complete lack of an elbow on an otherwise healthy sprout caused it to be listed in a separate class, "almost normal". Unfortunately, there proved to be hardly enough such sprouts to bring out any difference in interpretation.

These two samples were productive of some interesting results. They were representative of some seed produced by two local growers which had given trouble in the Ottawa laboratory. The seed had been grown in the hope of securing registered grade (Canadian highest quality seed), but adverse conditions had resulted in marked loss of vitality. It was felt that they might provide useful material for referee tests, and that, if such samples of low germination show excessive variability, this fact should be revealed. Professor Munn remarks, "It has been our observation that with onion seed of this strength and numerical figures, some wide variations can be expected. Some apparently identical series will vary widely in numerical value, seemingly more so than any other kind of seed."

As stated above, comparatively few "almost normal" sprouts were observed. In three cases out of four in which any considerable number was reported (more than 2%), the regular germination without such sprouts was higher than average. There is a slight tendency towards a negative correlation between "abnormal" and "almost normal" which may indicate that differences in interpretation may be between these two categories of sprouts, rather than between "almost normal" and "normal", as was expected.

In Sample No. 4 the chi-square test on all results for normal sprouts in tests between blotters gave a value for P of 10^{-8}, which is exceedingly small and indicates a lack of uniformity in results.

Detailed examination of the results of each station revealed three stations in which the results appeared to be excessively variable. The chi-square test for each station confirms this and at the same time indicates that one result in each station may be held to be unreliable, since in each case the results in question contributed much the greatest proportion to chi-square.

If these three results are eliminated and chi-square recalculated, we arrive at a value of 0.20 for P. This indicates that on the whole the blotter tests showed no greater lack of uniformity than that due to random sampling variations, and the series of tests, with the exception of the three excluded, may be considered satisfactory. It is possible, not not probable, that the three excluded values represented variations due to random sampling; but it is more likely that interpretational or experimental error was responsible.

In the sand tests, the value of P for all results was 5×10^{-5} - better than the blotters but still indicating excessive variability. One laboratory stated they had had little experience with germinating onion, and when the results for that station were omitted, P was nearly equal to 0.03, indicating far greater uniformity among the remaining laboratories, although even then the tests were not quite uniform enough. Probably more experience with sand as a medium for onion seed will conduce to greater uniformity.

The results for Sampel No. 5 gave P values for blotter and sand tests of

5×10^{-5} and 10^{-4} respectively. In this case again, the sand tests are slightly more uniform than the blotter tests, but there is great lack of uniformity throughout. Here, however, the chi-square test did not reveal any one or two results which contributed unduly to the magnitude of chi-square, as was the case with Sample No. 4. Instead of two or three excessive variations, there were several moderately large ones. This would seem to point, not to one or two tests in which the conditions broke down or in which an unusually aberrant replicate was secured by random sampling, but rather to a general state of somewhat unsatisfactory germination conditions. It is possible that seeds of this character are unusually sensitive to slight differences in moisture, temperature, and medium, so that differences between replicates would tend to be exaggerated. Compare Professor Munn's remarks on this point quoted above.

Analysis of variance of the results of the blotter tests would point to the same conclusions. Table 7 gives the results of this analysis.

TABLE 7.
ANALYSIS OF VARIANCE, SAMPLE NO. 5, BLOTTER TESTS

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	39	2072	53.15
Between means of laboratories	9	742	82.44
Remainder: within means of laboratories	30	1330	44.33
Snedecor's F ratio = $\frac{82.44}{44.33}$ = 1.86		5 percent point 2.22 1 percent point 3.09	

The fact that F is smaller than the 5% point, 2.22, indicates that there is not a significant difference between the "variance between laboratories" and that "within means of laboratories". In other words, the variation is as great on the average within any one laboratory as between the different laboratories, and thus the differences are not to be interpreted as systematic differences either in interpretation or experimental technique among the laboratories, but rather as a general tendency towards unsatisfactory germination conditions for seed of this kind.

However, these tendencies are not very marked. They would result in an increase in the range of variability of from ±10% to about ±14% as between individual replicates based on 100 seeds. Where 400 seeds are used for a test, the range increases from ± 5% to ± 7%. That is, where, for a sample germinating 50%, the results of tests affected only by sampling error should fall within the range 45 to 55% if it behaves like this sample it may be expected to give results ranging from 43 to 57%. There is still room for improvement in technique for this type of sample, but the results when analyzed are not found to be as badly out of line as might be suggested by a first inspection of them.

With regard to the general utility of the sand test, attention is directed to the decidedly close agreement of the averages of the sand and blotter tests. It may be concluded that sand, properly handled, has shown itself a suitable medium for germination of onion.

The stations included in Region No. 3 were the same as those listed in the report for this Region in the Proceedings for last year but in addition the

laboratories of the United States Dept. of Agriculture and the Iowa State College took part in the referee work. The cooperation given by all laboratories which were able to participate was very gratifying and much appreciated by the Regional Chairman.

Report for Region No. 4.

W. L. Goss

Carrot seed was selected for comparative germination test for two specific reasons: First, the samples illustrate the futility of even guessing at the germination of carrot seed by its appearance; and second, to show the small increase in germination obtained when the duration of test is extended from 14 to 30 days.

Five laboratories, namely, Colorado, California, Texas, Oklahoma, and Iowa, reported, and the results are tabulated herewith. The laboratories participating are indicated by number.

The tables both for the 14-day and 30-day results show in the column at the right the averages of the results of all laboratories on each sample and at the bottom, each laboratory's average on all six samples tested.

It is to be noted that Laboratory No. 4 is low on every sample. Except in Sample No. 74,748, the variation is not alarmingly wide, but the fact that it is always in the same direction from the others indicates either more conservative

TABLE 8.

SUMMARY OF CARROT SEED GERMINATION, REGION NO. 4, 1938.

Sample number	Percentage germination by laboratory number						
	1	2	3	4	5	Total	Average
			14-day test				
Danvers ½ long 74746	79	87	84	74	82	406	81
Long orange 74747	77	75	75	67	78	370	74
Chantenay 74748	70	71	64	45	70	320	64
Hutchinson 74749	39	47	41	37	41	205	41
Oxheart 74750	46	40	41	40	42	208	42
Hutchinson 74751	41	38	40	37	42	196	39
Average	59	60	58	50	59		57
			30-day test				
Danvers ½ long 74746	86	90	84	75	85	419	84
Long orange 74747	79	79	75	70	83	385	77
Chantenay 74748	78	79	66	46	80	350	70
Hutchinson 74749	41	48	42	39	43	212	43
Oxheart 74750	47	43	41	43	49	224	45
Hutchinson 74751	41	39	40	38	45	203	41
Average	62	63	58	52	64		60

counting or slightly less favorable conditions for germination.

The data in Table 8 summarize the results obtained.

The figures averaged to make the table are interesting in the consistency of the variation of values for the individual hundreds reported. By taking both the 14-day and the 30-day figures, we have 12 series of 20 individual tests made from seed from the same lot. The minimum number of values was 12, the maximum 16, and the average 13.5. Only once did the same value recur more than three times in the same sample.

Variations in germination for the 14-day test and the 30-day test:

Sample No.	14-day test %	30-day test %
74746	66 to 93	67 to 94
74747	54 to 82	59 to 85
74748	42 to 75	42 to 84
74749	29 to 50	30 to 51
74750	34 to 49	36 to 56
74751	31 to 49	33 to 50

Individual laboratories showed minimum, maximum, and average spreads between sets of four as follows on 30-day tests:

Laboratory No.	Min. %	Max. %	Average %
1	2	16	9
2	4	15	9
3	7	12	9
4	10	20	14
5	5	11	8

In addition to the blotter tests shown above, the Iowa Laboratory contributes the following results obtained by methods other than the ones in common use:

Sample No.	In sand		Top sand (petri dishes)		In soil	
	14 days	30 days	14 days	30 days	14 days	30 days
	%	%	%	%	%	%
74746	85	85	85	91	75	76
74747	74	75	75	81	66	72
74748	64	68	66	79	51	58
74749	41	42	43	45	23	29
74750	45	45	44	48	40	45
74751	36	39	37	38	25	27
Average	57	59	58	63	46	51

Tests were made at 20°-30°C., and in light at 30°C.

It is interesting to note that the sand tests made by the Iowa laboratory showed significantly better results in the three samples of relatively high germinating carrot seed, but were no improvement with the low germinating samples. Tests on top of sand at 14 days were equal to tests in sand, but at 30 days the number of sprouts was signfiicantly greater on top of sand. In soil the number

of sprouts was significantly lower than by either method with sand.

Firm seeds at end of test

The firm seeds of carrot which remain at the end of the normal germination period have long been a subject of discussion. Many of them are, undoubtedly, viable as witnessed by tests which have been continued far beyond the normal period in which a few seeds have sprouted each month. Light, nitrates, daylight, and different temperature combinations have been tried, but without significant results.

The firm seeds, remaining after 30 days, tabulated on the same basis as the germination results, are shown in Table 9.

TABLE 9.
FIRM SEEDS AT END OF TEST, BLOTTERS

Sample No.	Percentage firm seeds by laboratory number					
	1	2	3	4	5	Average
74746	9	5	10	16	12	10
74747	17	16	20	16	12	16
74748	16	17	27	32	14	21
74749	18	19	24	48	22	26
74750	34	35	38	47	27	36
74751	26	32	34	48	29	34
Average	20	21	26	35	19	24

Report for Region No. 5.
C. M. Bass

Region No. 5 was composed of 12 states and the District of Columbia. The states are:

Arkansas	Georgia	West Virginia
Louisiana	Kentucky	Maryland
Mississippi	Virginia	North Carolina
Alabama	Tennessee	South Carolina

In outlining the work for the year, letters were sent out to each official laboratory and to all commercial analysts in the region, soliciting their cooperation in regional referee testing. Seventeen laboratories replied and signified a desire to engage in the work. Of these, 12 were from official laboratories and five from commercial analysts.

Our objectives for the year were outlined as follows:

1. Greater uniformity in tests.
2. Work with problems pertaining to our region and those peculiar to individual laboratories.
3. Render all assistance possible to individual laboratories for the improvement of seed testing generally.

Under objectives 2 and 3, opportunity was given to render what seemed to have been a real worthwhile service and to ferret out some everyday problems confronting the average analyst. In a general letter to the laboratories, it

was announced that the number of samples and the kind of seed or problems we would work with would depend largely upon what was suggested by them. It was somewhat disappointing that so few suggestions were made.

Four samples were submitted during the year. These may be described as follows:

Sample No. 1 Crimson Clover (Trifolium incarnatum). This seed was of fair commercial grade; weed seed content was rather excessive, and it developed a considerable amount of broken seedlings, dead seeds, and hard seeds.

Sample No. 2. Dallas Grass (Paspalum dilatatum). This type of sample was requested by a number of laboratories. It frequently contains large amounts of ergotized seeds which aggravate both purity and germination analysts. At the request of the regional chairman, Dr. Toole, of the Division of Seed Investigation in Washington, prepared and distributed the samples and will carry the investigation through to a final conclusion. In submitting this sample, it was thought that it might lead to a possible solution to this troublesome problem. The sample was unavoidably delayed in going out; hence, the results of the tests are not available for this report.

Sample Numbers 3 and 4. Timothy (Phleum pratense). These samples were poor germinating seeds; each produced large percentages of weak seedlings which made them difficult but interesting to germinate.

In summarizing the reports on Samples 1, 3, and 4, it may be seen in Table 11 that for the most part the results are fairly uniform in Sample No. 1. There is a greater lack of uniformity in Samples 3 and 4. The weak seedlings in these samples unquestionably involve the personal judgment factor.

TABLE 10.

REPORT OF LABORATORIES TESTING SAMPLES NUMBERS 1, 3, and 4.

Official laboratories in region 5	13
Official laboratories reporting on all 3 samples	6
Official laboratories reporting on 1 or more samples	10
Commercial analysts participating	4
Commercial analysts reporting on all 3 samples	4

Splendid cooperation was received from both official and commercial analysts.

Referee Tests for the Association as a Whole

Three kinds of seeds were studied by small and large groups of analysts without regard to regional boundaries. All of the crops selected give frequent trouble and wide differences commonly occur. The tests includes lima beans,

TABLE 11.

SUMMARY OF REFEREE TESTS. REGION NO. 5, 1937-1938

Sample	Purity Analysis, Percent			Percentage Germination					
				Blotter				Soil	Sand
	Pure Seed	Inert	Weed Seed	Strong	Weak	Broken Seed-lings	Dead	Strong	Strong
No. 1 Crimson Clover									
High	98.7	1.5	1.6	88	8	14	7	79	87
Low	97.3	.1	.8	72	1	0	1	71	72
Mean	98.2	.6	1.1	78	4	10	4	75	81
No. 3 Timothy									
High				79	18		27	79	
Low				57	5		6	61	
Mean				69	10		18	70	
No. 4 Timothy									
High				69	22		32	68	
Low				58	6		7	60	
Mean				63	12		22	65	

sorghum, and blue grass. Tabular data and a discussion of the results for each crop follow.

Lima Beans

In the Spring of 1937, two lots each of Henderson Bush and Fordhook lima bean seed were obtained from a seed company in California, to be used in a referee test. Five official and two commercial laboratories took part in the tests which were made in the laboratory and some in the greenhouse and field. Substrata employed in the laboratory included paper towels, rag doll, roll test, sand, and soil. One laboratory was unable to make a field test. The summarized data are shown in Table 14. Additional data from a commercial laboratory in California and from the seed house which supplied the seed are given in Tables 15, 16, and 17.

Plantings were not all uniform, hence direct comparisons are difficult. Attention, however, should be called to the field data. Conditions present in different states or in different fields within the same state were variable. (See Laboratory No. 6, field plots 1 and 2, also data from Tables 16 and 17.) A comment made by a commercial analyst is worthy of note. "In all field tests it was noted that under good field conditions originally weak plants showed less and less variations from the normal as their growth continued, while under adverse field conditions, the variation was very pronounced." The field trials for Laboratory No. 6 bear out the above points. Plot 2 was planted later than Plot 1, the soil in the former was in better physical condition, germination was more prompt, and most of the bald heads became more or less normal in appearance, producing pods nearly as soon as those which earlier appeared far superior.

The most valuable information obtained was that a laboratory test in sterile sand or soil, where less variable factors prevail may be expected to give fairly uniform results. If greenhouse tests are uniformly made and cared for, uniform results may also be expected. Response in the field is bound to be highly variable.

TABLE 12.

TABULATION BY REPORTS BY LABORATORIES ON REFEREE SAMPLE NO. 1
CRIMSON CLOVER - MAILED OUT NOVEMBER 1, 1937

Percentage Germination

Laboratory	Blotter Tests					Soil		Sand	
	Dead	Hard	Broken	Strong	Weak	Strong	Weak	Strong	Weak
	%	%	%	%	%	%	%	%	%
Official Analysts Reports									
U.S.Dept. Agri.	5	8	13	72	2	79	2	—	—
Iowa	5	1	5	84	6	77	5	87	5
Iowa	5	2	6	83	4	—	—	84	2
Virginia	3	8	7	79	3	71	4	—	—
Virginia	6	8	10	75	1	—	—	72	2
Virginia	3	5	12	77	3	75	1	—	—
A	4	10	4	76	7	—	—	78	6
B	2	5	8	83	3	—	—	85	3
C	6	1	13	78	2	—	—	77	4
D	7	5	8	76	5	—	—	—	—
E	1	7	—	75	8	75	13	—	—
F	6	6	13	72	3	72	7		
Commercial Analysts Reports									
T	3	4	13	77	5	—	—	—	—
U	5	4	8	80	3	—	—	—	—
V				88	—	—	—	81	—
W	3	5	14	73	5	—	—	—	—
Mean	4	5	10	78	4	75	5	81	4
High	7	10	14	88	8	79	13	87	6
Low	1	1	0	72	1	71	1	72	2

Purity

Laboratory	Pure Seed	Inert Matter	Weed Seed	Other Crop	Blotter Index Value	Soil Index Value	Sand Index Value
	%	%	%	%			
Official Analysts Reports							
U.S.Dept. Agri.	98.4	.7	.9	.1	71	78	—
Iowa	98.2	.4	1.3	.1	82	—	85
Virginia	98.3	.5	1.1	.1	78	74	71
A	98.0	.8	1.2	.0	75	—	76
B	97.3	1.5	1.0	.2	81	—	83
C	98.7	.4	1.0	.0	77	—	76
D	98.7	.1	1.3	.0	75	—	—
E	98.1	.9	1.0	.0	74	73	—
F	98.1	.6	1.2	.0	71	—	71
Commercial Analysts Reports							
T	98.1	.6	1.6	.0	—	—	—
U	98.1	.7	1.2	.0	—	—	—
V	98.0	.5	.8	.1	86	—	79
W	98.4	.5	1.1	.1	72	—	—
Mean	98.2	.6	1.1	.1	77	75	77
High	98.7	1.5	1.6	.2	86	78	85
Low	97.3	.1	.8	.0	71	73	71

TABLE 13.

TABULATION BY REPORTS BY LABORATORIES ON REFEREE SAMPLES NOS. 3 & 4, TIMOTHY - MAILED OUT JANUARY 11, 1938

Laboratory	Blotter Tests Strong %	Blotter Tests Weak %	Blotter Tests Dead %	Soil Tests Strong %	Soil Tests Weak %	Greenhouse Tests
Sample No. 3						
Official Analysts Reports						
U.S.Dept. Agri.	64	9	27	66	—	(75% normal
Iowa	77	7	16	74	0	(seedlings in
Iowa				(1) 79	8	(19 days
Virginia	71	14	15	(3) 62	11	
Virginia (2)	67	9	24	(4) 61	—	
A	67	8	25	71	5	
C	78	5	17	76	5	
E	75	8	18	—	—	
G	61	18	21	67	16	
Commercial Analysts Reports						
T	72	15	9	—	—	
U	65	11	24	—	—	
V	57	13	6	71	5	
W	79	5	17	—	—	
Mean	69	10	18	70	8	
High	79	18	27	79	16	
Low	57	5	6	61	5	
Sample No. 4						
Official Analysts Reports						
U.S.Dept. Agri.	58	12	30	60	—	(65% normal
Iowa	65	11	24	67	8	(seedlings in
Iowa				(1) 68	8	(19 days
Virginia	64	18	18	(3) 60	11	
Virginia (2)	61	15	24	—	—	
A	59	10	31	67	8	
C	61	7	32	68	6	
G	62	15	24	65	19	
Commercial Analysts Reports						
T	63	22	7	—	—	
U	65	11	25	—	—	
V	61	10	7	61	7	
W	69	6	25	—	—	
Mean	63	12	22	65	10	
High	69	22	32	68	19	
Low	58	6	7	60	6	

Notes:

(1) Pre-chilled at 8-10°C. 3 days, 20-30°C, 7 days.
(2) Petri dish with KNO_3 and light.
(3) Petri dish with sand and light.
(4) Soil test.

TABLE 14

SUMMARY OF LIMA BEAN GERMINATION TEST, 1937

Laboratory number and substrata	Percentage Germination: Laboratory Normal	Laboratory Bald heads	Laboratory Abnormal	Laboratory Dead	Sand Number emerged	Sand Bald heads	Sand First Set of Leaves	Field Number emerged	Field Bald heads	Field Normal	Field Final normal
	%	%	%	%		%	%		%	%	%
Lot A											
1. Paper towels	89	6	4	0.3	99 (1)	4	93	82	5	76	
2. Rag doll	90	--	10	--	92 (2)	3	89	85	7	80	
3. Roll test	48	4	15	34	95 (2)	4	91	79	3	73	
4.					91 (3)	4	87	70	9	61	
5. Paper towels	89	5	2	5	95 (2)		91				
6. Plot 1. Sand	96	8	4		97 (2)	7	90	81	6	75	81
Soil	98	4	2								
Plot 2.								90	5	85	91
Lot B											
1. Paper towels	78	10	12	0	94 (1)	6	88	73	6	61	
2. Rag doll	82	2	15	2	82 (2)	8	80	80	5	74	
3. Roll test	59	5	11	25	88 (2)	8	80	71	6	62	
4.					75 (3)	11		62	10	52	
5. Paper towels	76	7	5	13	92 (2)	10	82				
6. Plot 1. Sand	95	7	5		80 (2)	8	72	75	10	66	74
Soil	92	9	8								
Plot 2.								79	6	73	79
Lot X											
1. Paper towels	85	3	10	2	96 (1)	4	85	77	3	61	
2. Rag doll	87	2	11	1	87 (2)	3	84	88	1	83	
3. Roll test	48	1	26	26	92 (2)	3	89	51	3	47	
4.					79 (3)	6		72	22	50	
5. Paper towels	82	4	6	9	89 (2)	10	80				
6. Plot 1. Sand	94	1	6		81 (2)	2	80	80	4	76	81
Soil	97	3	3								
Plot 2.								88	2	86	88
Lot Y											
1. Paper towels	78	3	4	2	95 (1)	4	85	79	4	54	
2. Rag doll	97	0	4	0	89 (2)	2	84	85	2	80	
3. Roll test	53	1	25	21	96 (2)	4	92	70	3	61	
4.					76 (3)	4		71	27	44	
5. Paper towels	87	3	7	4	91 (2)	7	83				
6. Plot 1. Sand	99	5	1		85 (2)	4	81	84	6	78	86
Soil	97	4	3								
Plot 2.								88	2	87	88

(1) Sand in laboratory.
(2) Sand in greenhouse.
(3) Non-sterile sandy loam (laboratory).

The tests with all lots in greenhouse sand made by Laboratory No. 6 were not run simultaneously nor in the same house. Lot A was tested first in a shaded house in July, lots B, X, and Y in a non-sahded house in August. Water was not always supplied at the proper time. (Seed laboratory sand and soil tests.)

TABLE 15

COMPARISON OF GERMINATION TESTS ON REFEREE TEST SAMPLES OF LIMA BEANS. (1)
SEPTEMBER 17, 1937. RESULTS ARE GIVEN IN PERCENTAGES

Descriptions	Henderson Bush Limas							Fordhook Limas					
	Lot A				Lot B			Lot X		Lot Y			
	Lab. Test	Green house test	Field test (3)	Field test (4)	Lab. test	Green house test	Field test 1	Lab. test	Field test 1	Lab. test	Green house test	Field test 1	Field test 2
Spindly			3	0.4			5		4			3	
Blunt roots								10					
Freaks (three cotyledons)													1
No cotyledons					0.3	0.4							2
Knees	2	3		2	7	2				1	1		
Bald Heads	3	5	1	8	8	6	3	1	2	9	5	2	3
Field injury				3									7
One cotyledon	4	1		12	4	7		1		1	1		3
Rot spots on cotyledons								3			9		2
Primary leaf injury				3	1			1					3
Normal Plants	86	87	77	61	64	62	60	74	69	73	66	74	54
Total Emergence	95	96	81	88	85	78	69	88	75	93	74	79	72
Corrected Germination (2)	90	88	77	75	70	69	60	77	69	83	67	74	60

(1) The figures used are averaged percentages: Laboratory test - four samples of 100 seeds each. Time: 7 days; medium - sand. Greenhouse test - four samples of 50 seeds each. Time: 12 days. Field test 1 - five samples of 100 seeds each. Time: 14 days. Field test 2 - Lot A, 225 seeds; Lot Y, 200 seeds. Time: 10 days

(2) Since plants with one cotyledon, or rot spots on cotyledons, or with primary leaf injury, yield as well as normal plants in the field, they are counted with the normal plants to give the corrected normal germination percentage. (See Table 17).

(3) Field test 1 was run at the trial field in El Monte in sandy loam soil.

(4) Field test 2 was run at Santa Barbara in heavy adobe soil. (See Table 17).

TABLE 16

COMPARISON OF PRELIMINARY AND FINAL COUNTS ON FIELD TEST NO. 1. SEPTEMBER 17, 1937. RESULTS ARE GIVEN IN PERCENTAGES.

Description of plants	Henderson Bush Limas				Fordhook Limas			
	Lot A		Lot B		Lot A		Lot B	
	7 days	14 days	7 days	14 days	7 days	14 days	7 days	14 days
No cotyledons	2		3		0.4			
Spindly		3		5		4		3
Knee					0.2		0.4	
Bald heads	3	1	6	3	3	2	2	2
One cotyledon	6		7		2		2	
Primary leaf injury			0.4		1		1	
Normal plants	68	77	50	60	61	69	64	74
Total emergence (1)	80	81	66	69	68	75	70	79
Corrected germination (2)	75	77	57	60	64	69	67	74

(1) Wire worm injury in the field tests reduced the total emergence.
(2) Corrected germination is obtained by adding the plants with one cotyledon and the plants with primary leaf injury to the normal plants. (See Table 17).

TABLE 17

FIELD TESTS AT SANTA BARBARA, CALIFORNIA, SEPTEMBER 17, 1937.

Description of plants	Henderson Bush Limas (A)		Fordhook Limas (Y)	
	Number plants emerged	Aver. number pods per bush	Number plants emerged	Aver. number pods per bush
Normal plants	137	22	105	18
Primary leaf injury	6	21	5	19
Rot spots in cotyledons			3	18
One cotyledon	26	19	5	16
Field injury, lesions	7	12	13	11
Bald heads	17	10	6	9
Knees	4	10		
No cotyledons			3	4
Freak (three cotyledons)			1	2
Wire worm injury			2	2
Spindly	1			
Total emerged plants	198		143	
Unemerged plants				
Rotten	11		42	
Broken	7		7	
Curled	7		8	
Other causes	2			
Total emerged and not emerged	225		200	

Note: Presence of wire worms reduced emergence in all field tests. Pod counts made 90 days after planting, at time of harvest, emergence count after 10 days. The large number of one-cotyledon plants in the Henderson Bush test may be due to the heavy adobe soil through which the plants had to push their way.

Tests with sorghum

Three official laboratories and one seed company participated in a referee test with red amber sorghum supplied by the Iowa Laboratory. Tests were made in sand and between blotters, each at 20°-30°C. The number of normal sprouts which appeared on different days were recorded, also abnormal seedlings, fresh ungerminated seed, and dead seed. The complete data are given in Table 18. The results show good agreement between the two methods and between laboratories.

TABLE 18
SUMMARY OF REFEREE TESTS WITH RED AMBER SORGHUM. 1938.

Laboratory	Substratum	Percentage Germination: Normal Sprouts by days 2	3	4	5	8	Total	Abnormal	Fresh Ungerm.	Dead
		%	%	%	%	%	%	%	%	%
Bowman Seed Company	Blotter	47	33	--	13	2	94	2	3	2
	Sand	--	--	94	3	0.5	97	4	--	--
Iowa	Blotter	54	39	--	0.3	0.2	94	1	2	2
	Sand	--	--	91	0.8	--	92	--	--	--
Kansas	Blotter	0.2	94	--	2	0.2	96	0.3	1	3
	Sand	--	--	91	0.5	0.2	93	0.3	--	--
Nebraska	Blotter	26	40	--	27	2	94	0.5	2	3
	Sand	--	--	23	61	11	94	0.5	--	--
Mean	Blotter	--					94			
	Sand	--					94			

Referee Tests with Bluegrass Seed

Referee tests with bluegrass have shown a lack of uniformity in purity and germination tests when the official method was employed by seed analysts. Lack of uniformity among laboratories in germination is caused, in part, by (a) un-uniform conditions for each replicate in a set, (b) different techniques employed by laboratories, and (c) un-uniform pure seed fractions from which seeds are selected for germination.

The design of this particular referee test was such that data bearing on the following factors and comparisons could be obtained.

(a) Effect of techniques in individual laboratories on seed germination.

(b) Effect of variations in personal judgment as to what constitutes pure seed.

(c) Comparative uniformity of the official and modified methods of procedure in purity analyses.

The procedures used in preparing the sub-samples for the referee test were as follows:

(a) From a sample of bluegrass seed, bushel weight of which was 22.5 pounds, approximately 64 grams were obtained and sub-divided into 64 sub-samples.

(b) Each sub-sample was analyzed by the Iowa method, using a new air blast separator operated by a constant speed motor and fan.

(c) The pure seed fractions from 32 of the sub-samples were designated as sample "a" and sent to each of 32 laboratories.

(d) The separations from the remaining 32 sub-samples were respectively recombined and each of the 32 cooperating laboratories received one sample with the request that an official analysis and test for germination be made. Each sub-sample was designated as sample "b".

(e) Two methods for germination with pure seed fractions "a" were requested (1) on top of moist sterile sand in petri dishes, the sand weighed and a given quantity of distilled water added, and (2) on top of moist filter papers in petri dishes.

The purities of the 64 sub-samples as determined by the Iowa method showed a difference in extremes of 2.43 and a mean of 88.69%. Calculation of chi-square gave a value such that the standard normal deviate was 1.75, which is equivalent to a probability above the 5% point. The differences, therefore, were not considered as significant. Repeated germination tests on other similar sub-samples gave from 88 to 91% on top of moist sand. The pure seed fractions were considered to be exceptionally uniform, much more so than when human judgment is relied upon as the criterion.

Twenty-six of the 32 laboratories completed the tests and the complete data as reported by each laboratory are given in Table 19. In addition, the percentage of pure seed for each of the 52 sub-samples as determined by the Iowa laboratory is given to show the uniformity of the results obtained by the modified method.

Nineteen of the 26 laboratories removed less than 1% inert from the pure seed fraction designated as "a", six removed between 1 and 2% and one removed more than 2%. Apparently a part of these differences give some measure of variations in personal judgment.

The results with sub-samples designated as "b" are of interest in that the difference in extremes by the Iowa method is 1.86, whereas the difference by the official method as employed by 26 analysts is 6.26. The latter difference is far too great for homogeneous samples of bluegrass seed with a purity of nearly 89%.

Discussion of germination

Inasmuch as the pure seed fractions marked "a" were considered uniform, it was anticipated that fairly close agreement in germination would be obtained. In nine tests from separate laboratories, five on sand and four on filter paper, the variation among the four replicates was more than should be expected from uniform pure seed fractions and the mean of such a test should not be included in making comparisons with other laboratories.

If the percentages marked with an asterisk be eliminated the variability is too great for uniform pure seed fractions by either method, hence it was considered unnecessary to calculate chi-square. Percentages below 86% should probably be considered as caused by the techniques employed.

TABLE 19

SUMMARY BLUEGRASS REFEREE TEST, 1938.

Laboratory	Sample A, percentages					Sample B, percentages			
	Germination			Inert from pure seed	Pure seed Iowa method	Official method			Pure Seed Iowa method
	Top Sand	Own method	Highest test			Pure seed	Germination	Normal sprouts inert	
1	91	92	92	.6	88.0	89.4	85	7	88.3
2	89	84	89	.5	87.7	90.6	84	---	89.1
3 (1)	90	85	90	.2	88.8	88.9	87	10	88.6
4	64*	82	82	.6	88.7	94.2	55	---	89.0
5	72	76*	76*	.6	89.5	90.2	82	2	89.6
6	87	90	90	.5	87.7	90.4	88	0	88.5
7	86	83	86	1.2	89.0	90.2	82	2	88.4
8	88	84	88	.3	88.5	92.4	79	2	88.6
9	81	85	85	.5	89.0	91.2	85	6	88.0
10	84	87	87	.5	88.6	91.0	76	4	88.7
11	74*	75*	75*	.4	89.1	91.0	69	0	88.5
12	87	85	87	.4	88.9	93.8	85	3	89.4
13	87	87*	87	.3	88.6	91.4	79	---	88.6
14 (2)	81*	87	87	2.3	87.6	89.2	79	15	89.3
15 (3)	91	90	91	.8	88.4	91.6	83	---	88.9
16	86*	84	86*	1.1	89.3	89.5	84	---	88.4
17	91	91	91	.3	89.1	92.6	78	---	89.1
18	84	90	90	1.4	87.9	90.6	80	16	88.9
19	88	85	88	2.0	88.6	88.0	83	6	89.4
20	85	92	92	.3	87.3	91.6	84	---	89.0
21	88	87*	88	.8	89.2	92.1	81	2	88.8
22	90	88	90	1.1	88.9	88.4	88	11	88.1
23	77*	84	84	.2	87.9	91.1	81	3	87.8
24	86	90	90	.5	88.6	91.2	87	2	88.2
25	85	90	90	.8	89.4	90.3	91	3	89.9(4)
26	82	89	89	1.4	87.9	87.4	86	0	88.6
Mean			88	.8		90.7	81		
P			<.01						

(1) Iowa Laboratory.
(2) U. S. Department Agriculture Laboratory.
(3) Swiss Laboratory.
(4) A second sample; not included in original 64 sub-samples.

* Variation among replicates too great for uniform samples. Data should not be used in making comparisons with other laboratories. Not used in computing means.

In the third column marked "highest test", is given the highest figure by either method and if the percentages marked with an asterisk be omitted, the variation is still more than should be expected in that the probability is less than 0.01. Variations below the normal must be considered as caused by laboratory technique.

The germination tests with the sub-samples designated as "b" are extremely variable and are caused, in part, by differences in purity, the higher the purity the lower the germination in general; however, some of the differences are undoubtedly the result of variation in techniques employed by the several labora-

tories.

Conclusions which seem justifiable as a result of this referee test are:

(a) The modified method of procedure for a purity analysis are employed in the Iowa Laboratory provided more uniform pure seed fractions than when each of 26 laboratories used the official method of analysis. The machine is less variable than human judgment.

(b) Greater uniformity in germination resulted when pure seed fractions were obtained by the modified method of procedure than by the official method.

Reports of Sub-Committees

Eight sub-committees have worked on problems pertaining to the work of the Research Committee. The reports of these sub-committees will be given by the various chairmen. These reports are numbered as follows as a matter of convenience.

1. Study of brome grass analysis - A. C. Heise, Edith C. Higgins, Ruby U. Crouley, R. H. Porter, and Verna Jane Thompson.

In the fall of 1937 the seed laboratories in North Dakota, Manitoba, Minnesota, and Iowa undertook a study of techniques for the analysis of brome grass seed; the major purpose being to determine the advisability of using five grams of low purity samples for analysis rather than 10 grams. A study of germination methods was also undertaken.

Procedure. Early in October three lots of brome grass seed were selected by the Iowa Laboratory, from each of which four sub-samples, weighing approximately 10 grams each, were drawn. Each sub-sample was then divided into two portions, "a" and "b". A set of the paired sub-samples (five grams) was sent to each of the four cooperating laboratories with the request that a purity analysis be made of each small sub-sample and a germination test of one sub-sample from each lot. Following the completion of the above, the North Dakota laboratory sent out similar sub-samples from each of two lots. The data obtained are shown in Table 20. Samples 7565 and 7569 were supplied by the North Dakota Laboratory.

Discussion of results.

Purity. With the first three samples, 28690, 28716, and 28766, none of the laboratories obtained significant differences in purity between the two 5-gram sub-samples of any sample. The mean purity for each laboratory of any one sample is equivalent to the purity percentage that would have been obtained had the two 5-gram sub-samples been analyzed as one 10-gram sub-sample. Calculation of chi-square values and of probabilities using (a) the purity percentages from all of the small sized sub-samples and (b) the mean purity percentages gave results as follows:

TABLE 20

PURITY AND GERMINATION OF BROME GRASS SEED, USING 5-GRAM SUB-SAMPLES.

Sample number and treatment	Iowa			Minnesota			North Dakota			Winnipeg		
	Weight grams	Per cent pure	Per cent germ.	Weight grams	Per cent pure	Per cent germ.	Weight grams	Per cent pure	Per cent germ.	Weight grams	Per cent pure	Per cent germ.
28690 a	4.900	65.7	92	5.045	65.8		4.650	66.1		5.384	67.4	
b	4.900	67.9	91	5.568	66.9		5.545	66.7				
Mean (10 g.)		66.8	92		66.4	93		66.5	87		67.4	87
28716 a	4.789	61.1	94	5.020	63.5		5.115	63.6		5.600	62.6	
b	4.695	61.8	91	5.060	64.4		4.830	64.1				
Mean (10 g.)		61.4	92		64.0	85		63.8	82		62.6	81
28766 a	4.400	68.2	91	4.362	72.5		4.845	71.7		5.162	71.4	
b	4.668	70.2	90	4.440	70.4		4.650	72.4				
Mean (10 g.)		69.1	91		71.5	87		72.0	91		71.4	84
7565 a	5.098	81.2		5.110	82.3		5.405	83.3		5.321	79.9	
b	5.068	81.6		5.190	84.0		5.255	80.6		5.163	84.1	
Mean (10 g.)		81.4	91		83.2	92		81.9	93		82.0	91
7569 a	5.191	77.5		5.045	76.5		5.140	78.6		5.125	76.0	
b	5.190	77.0		5.460	78.2		5.255	75.9		5.377	76.0	
Mean (10 g.)		77.3	87		77.1	91		77.3	89		76.0	82

Sample	Probability values for All sub-samples (5 grams)	Mean purities (10 gram sub-samples)
28690	.96	.85
28716	.45	.15
28766	.18	.04

The uniformity of results is satisfactory except for sample 28766 when the purities based on 10-gram sub-samples are considered together, however, a value of 0.04 may not necessarily be serious although one point below the 5% value.

With samples 7565 and 7569 the differences between the purities of 5-gram sub-samples is significant only for 7565 at the Winnipeg laboratory in which case probability is slightly less than 0.01. As between the mean purities for both 7565 and 7569 the differences are not significant. Using all eight analyses for sample 7565 the chi-square is 17.61 and the probability is 0.015, which is significant, indicating that differences as great as those obtained should not be expected from uniform sub-samples of seed. If the means be taken, however, and computations completed, the probability is 0.25, indicating more uniformity of samples. The data obtained in these tests indicate that for low quality samples of brome grass seed, a close and reasonably reliable approximation of purity may be obtained by the use of a 5-gram sub-sample.

Germination. A study of the viability tests with the five samples used for purity analysis in Table 20 reveals considerable variation in results obtained by the four laboratories. The data for sample 7565 are uniform. On the basis of the chi-square test, the probability values for all samples except 7565 were found to be as follows:

Sample Number	Chi-square	Probability
28690	12.06	$<.01$
28716	23.11	$<.01$
28766	12.83	$<.01$
7569	61.54	$<.01$

The differences as reported by the four laboratories are greater than should be expected from uniform pure seed fractions, hence either the technique of germination was not uniform or the pure seed fractions were dissimilar.

To investigate further the problem of uniformity in germination of brome grass seed, four sub-samples were drawn from a uniform pure seed fraction and one was sent to each laboratory. One copper tray with wicks, designed in the Iowa Laboratory, was sent to North Dakota where a test was made and the tray forwarded to Winnipeg, thence to St. Paul. Distilled water and the same kind of blotters were used in all tests. The results with chi-square and probability values are shown in Table 21. The differences as between the four laboratories with copper trays were not significant.

The method used by each laboratory gave uniform results from which we might conclude that the reasons for significant differences in germination as shown in Table 20 are to be found in the possibility of un-uniform pure seed fractions used in the earlier tests even though differences in purity were not found to be

TABLE 21

COMPARISON OF METHODS OF GERMINATION WITH BROME GRASS. TEMP. 20°-30°C.

Method	Iowa	Minnesota	North Dakota	Winnipeg	X^2	P
Own method	89	91 (2)	87	89 (3)	3.241	.32
Copper tray with wicks	89 (1)	91	88	86	4.960	.18

(1) Regular method.
(2) Dark between blotters.
(3) Pre-chilled two days at 8°C. on top of soil in light.

statistically significant. For sample 28716, the Iowa Laboratory obtained lower percentages of purity than the other three laboratories and a higher germination than the others except in comparison with North Dakota sample 28766.

2. Study of blue grass analysis - C. W. Leggatt, F. A. McLaughlin, F. M. Torpy, A. C. Heise, W. A. Price, and R. H. Porter.

The purpose of this sub-committee is to study accuracy of separation by mechanical methods in different laboratories, using synthesized and commercial samples of bluegrass. One of the reasons for differences in purity reports from separate laboratories may well be found in dissimilar air blast separators and air pressures. The tests conducted by this committee were designed to throw some further light on the problem of uniform analyses.

Two samples were used, but one was not properly prepared, therefore the results obtained with it are not included. The second sample was a synthetic one prepared as follows:

1. Six sub-samples from a bluegrass lot weighing 28 pounds per bushel were blown individually at a pressure slightly above the maximum considered necessary, after which all other foreign material was removed from the heavy portion. The new Iowa air blast separator was used to make the separations.

2. A lot of bluegrass weighing 10 pounds per bushel was blown at a pressure much below the maximum and the florets blown over were stained with safranin.

3. Stained material was then added to the heavy fraction from each of the six sub-samples so that the weight of heavy constituted 80% of the total.

Each laboratory received one synthesized sub-sample which should be considered as representing two extremes of blue grass florets, namely (1) heavier than average pure seed, and (2) lighter than average florets normally considered as inert. The request made was that the sample be blown five successive times each for 15 minutes, starting at a low pressure and increasing to that considered as the maximum for accurate separation. At the conclusion of each test, the percentage of heavy was determined, the number of stained florets in the heavy portion and the number of unstained florets in the light weight fraction. It is difficult to judge the Winnipeg results because weights alone were given. The data for this study are given in Table 22.

It is believed that the data for sample No. 2 suggest that un-uniform separation of inert florets by air blast may be caused by such factors as (1) uneven or un-uniform pressure, (2) too high a pressure in the early part of the operation, (3) too long a period at a pressure slightly above the optimum, and (4) improper design of the compression chamber.

TABLE 22

SUMMARY OF RESULTS OBTAINED BY SIX LABORATORIES USING A SYNTHETIC SAMPLE OF BLUE GRASS SEED.

Laboratory Replications	Iowa analysis at synthesis				Modified analysis			Official method		
	Weight (grams)			Per cent unstained	Per cent heavy	Number stained in heavy	Number unstained in light	Per cent pure	Number stained in pure	Number unstained in light
	Stained	Unstained	Total							
Kentucky	.208	.832	1.040	80.0				not reported		
1					81.23	26	3			
2					81.04	47	5			
3					81.10	39	2			
4					81.59	44	5			
5					80.96	75	2			
Iowa	.200	.800	1.000	80.0				79.92	0	12 (1)
1					80.02	4	2			
2					79.98	6	2			
3					80.00	2	4			
4					80.12	4	6			
5					80.08	5	4			
Massachusetts	.195	.781	.976	80.0				80.65	50	5
1					80.47	7	2			
2					80.47	7	2			
3					80.44	6	2			
4					80.49	7	2			
5					80.44	6	2			
Ottawa	.195	.780	.975	80.0				not reported		
1					80.10	None	1 or 2			
2					80.25	observed	"			
3					80.31	"	"			
4					80.43	"	"			
5					80.34	"	"			
U.S.Dept.Agri.	.177	.710	.887	80.0				80.31	0	32 (2)
1					80.34	33	13			
2					79.19	33	87			
3					79.28	31	82			
4					79.30	28	70			
5					79.21	13	77			
Winnipeg	.185	.639	.924	80.0		grams		80.23	2	21
1					80.47	.0000	.0007			
2					80.01	.0006	.0046			
3					80.13	.0009	.0039			
4					80.15	.0002	.0041			
5					80.40	.0000	.0014			

(1) 17 were unattached florets, 15 were attached but removed by separation.
(2) All attached florets which were separated by hand.

The percentages of heavy in these experiments with sample No. 2 are not as important as fineness of separation between stained and unstained, however, four out of six laboratories obtained rather uniform percentages of purity in the five trials. Differences in weight are due to changes in moisture. Samples tested the day they are received lose more weight than those kept in the laboratory several days, except in periods of high humidity when absorption of moisture occurs.

3. Pathological aspects of seed analysis - R. J. Haskell, F. A. McLaughlin, W. F. Crosier, G. A. Scott, and R. H. Porter.

In the fall of 1937, one sample of Komar wheat and one of Ioglos barley, each from the 1937 crop, were selected by the Iowa Laboratory for study by other laboratories. The season of 1937 was fairly favorable for the development of head blight of cereals caused by Gibberella saubinetii and related species of Fusarium. Each lot was divided into two portions, one left untreated, the other treated with 1% ethyl mercury phosphate prepared by diluting New Improved Ceresan one part with four parts of French talc.

Willard Crosier (New York), R. J. Haskell (U. S. Dept. Agri.), F. A. McLaughlin (Mass.), and G. A. Scott (Ottawa) cooperated with the Iowa Laboratory in the tests.

Germination tests were made in blotters or towels and in sand or soil in the laboratory. In one case a greenhouse test was made and Mr. Scott made a test in petri dishes on agar.

The data obtained are summarized in Tables 23, 24, and 25.

One of the most interesting results of these tests is the uniformity of germination when treated seed was used, regardless of the substratum employed. Probability is above 0.05 in all cases. On the other hand, considerable difference of opinion concerning normal seedlings was evidenced when untreated seed was used.

In view of the increased use of seed disinfectants on commercial seed lots, it is evident that more tests of the type herein described are necessary, if any degree of standardization or uniformity is to be achieved among laboratories.

4. Viability of injured weed seed - C. M. Bass.

At the last meeting of the Association, considerable thought and discussion were given to the subject of "Viability of injured weed seeds." As a result of this interest, it was suggested to the Research Committee that this was a matter which deserved some systematic study.

The subject was assigned to the Chairman of Region No. 5. Some studies on this work had already been done, most of which were confined to an important, but rather small, number of kinds as compared with the actual number of species which are involved and which need consideration.

Realizing the magnitude of the field and the project, an effort was made to first give those who had been working on the subject an opportunity to continue their investigations with the species in which they were interested.

The work for the year was confined to eight groups of seeds. These were assigned in the following manner together with recommendations as an aid in systematizing the work:

TABLE 23.

SUMMARY OF REFEREE TEST WITH TREATED AND UNTREATED KOMAR WHEAT.

Cooperating laboratories	Percentage germination and diseased														
	Treated							Check							
				Diseased							Diseased				
	Normal	Abnormal	Dead	S. (1) blight	Others	Total	Poisoned	Normal	Abnormal	Dead	S. (1) blight	Scab	(6) H. S.	Others	Total
Blotters and towels in laboratory															
New York	87	2	8			6	0.2	67	0.2	11		42			64
U.S.Dept. Agri. (2)	91	2	7			2	0.2	78	11	12					21
Massachusetts	92	2	2			2	2	80	2	7					11
Iowa	91	2	8			3	—	84	7	10		19(5)	75		94
Ottawa (3)	91	—	8			2	—	83	7	5					5
X^2	6.49														
P	.15														
Soil or sand															
New York	88	1		1	1		—	56	0.2	—	9			14	
U.S.Dept. Agri. (2)	88	6	6	1	—		—	60	3	27	23				
Massachusetts	87	4		2	2		1	63	6		27			27	
Iowa	91	1	8	1	—		—	71	9	21	9			(4)	
Ottawa (3)	92	1	7	1	2		—	57		30	14			44	
X^2	8.70														
P	.07														
Additional tests															
New York - soil in greenhouse	92	2	6	0.2	—		—	65	9	26	20				
Porter - sand in laboratory	89	0.2	11	—	2		—	68	11	11	9				

(1) Seedling blight.
(2) Soil in laboratory eight days - greenhouse three days.
(3) Sand.
(4) Not determined.
(5) Includes 10% dead and 9% seedlings.
(6) H.S. - Helminthosporium sativum.

TABLE 24

SUMMARY REFEREE TEST WITH TREATED AND UNTREATED IOGLOS BARLEY

Cooperating laboratories	Percentage germination and diseased														
	Treated							Check							
				Diseased							Diseased				
	Normal	Abnormal	Dead	S. (1) blight	Others	Total	Poisoned	Normal	Abnormal	Dead	S. (1) blight	Scab	(3) H. S.	Others	Total
Blotters and towels in laboratory															
New York	96	1	2			3	1	82	0.2	3		51	—		66
U.S.Dept. Agri. (2)	98	2	1			1	—	96	2	2		—	—		21 (3)
Massachusetts	98	1	1			10	0.2	86	13	2		—	—		51
Iowa	99	1	1			6	—	96	3	1		4	81		95
Ottawa (4)	99	0.2	1			—	—	98	2	0.2		—	—		1
X^2	8.22														
P	.08														
Soil or sand															
New York	98	0.2		0.2	0.2		—	88	1	—	7			13	
U.S.Dept. Agri. (2)	98	1	1	—	—		0.2(?)	79	17	4	41			—	
Massachusetts	96	1	—	—	—			96	2	—	5			5	
Iowa	97	—	3	1	—		—	91	4	5	3			8	
Ottawa (4)	98	1	2	1	—		—	81	9	4	9			43	
X^2	3.905														
P	.42														
Additional Tests															
U.S.Dept. Agri.soil in greenhouse	98	1	1	1	—		—	83	11	7	16			—	
Iowa - sand in laboratory	98	0.2	2	—	2		—	92	4	5	3			15	

(1) Seedling blight.
(2) Soil in laboratory eight days - greenhouse three days.
(3) H. S. - Helminthosporium sativum.
(4) Sand.

TABLE 25

RESULTS WITH 50 SEEDS OF WHEAT AND BARLEY IN PETRI DISHES (OTTAWA).

Crop	Percentage germination			Percent fungous infection	Identifications (percentages)			
	Strong	Weak	Total		Helmintho-sporium	Fu-sarium	Alter-naria	Unde-termined
Wheat								
Treated	76	6	82	20	2	4	10	4
Check	40	8	48	100	42	12	44	2
Barley	66	12	78	38	8	14	12	4
Treated	24	4	28	100	54	12	34	0
Check								

Anna M. Lute, Colorado.

Rumex Spp. (To include both injured and immature seed, but handled separately.)

A. L. Stone, Wisconsin.

Agropyron repens (To include both injured and immature seeds, but handled separately.)

F. S. Holmes, Maryland

Lepidium and other Crucifereae

W. H. Wright and C. W. Leggatt, Ottawa, Canada.

To continue their studies on Ambrosia artemisiifolia and Setaria viridis.

L. N. Allen, Alabama.

Digitaria spp. (Especially sanguinalis).

R. H. Porter, Iowa

Amaranthus spp.

W. O. Whitcomb, Montana.

Chenopodium spp.

Jennie S. Jones, Virginia.

Allium vineale (bulblets).

These assignments were received with considerable interest and enthusiasm.

Reports of progress have been received on four of these assignments. A brief summary of these reports is as follows:

A. M. Lute, Colorado:

Rumex crispus. Twelve tests were made, all from 1937 crop; condition of seed varying from no injury to slight injury; these germinated from 60 to 100%. Slightly injured seed did about as well as un-injured seed.

Polygonum aviculare. Nine tests were made from 1935, 1936, and 1937 crops; condition of seed varying from immature and no apparent injury to various degrees of injury. Germination varied from 0 to 50%. Older seed germinated as well as new.

Polygonum persicaria and Polygonum scandens. Single samples of mature un-injured seeds of each germinated a maximum of 33%.

Polygonum convolvulus. Ten tests from 1937 crop were made; condition of seed varying from slightly immature and no apparent injury to severely injured. Germinated from 0 to 60%.

Helianthus annuus. Five tests made from 1937 crop. Condition of seed varied from serious injury to no injury, with germination varying from 9 to 60%.

A. L. Stone, Wisconsin:

Agropyron repens. Thirty-six samples germinated from 0 to 92% in from 3 to 30 days. Age of seed varied from 1933 to 1937 crops. Seeds were injured or denuded to various degrees and were germinated on filter paper and on blotter, in both light and dark, and at temperatures ranging from 20° to 30°C.

Verna Jane Thompson, Iowa:

Amaranthus spp. Material used was taken from two samples of screenings furnished by seedsmen. Four tests of 4 x 100 seeds were made from each. Seeds tested were classified as unbroken, slightly broken, and seriously damaged (over half the seed coat removed). Tests were conducted at 20° to 30°C. in daylight germinator on blotters in petri dishes. Considerable growth was recorded in 24 hours; final counts were made in 96 hours. Seedlings were classified as normal and abnormal, the latter considered as incapable of producing plants even under favorable conditions. The results are as follows:

		Percentage Germination		
	Number seeds used	Total	Normal	Abnormal
Un-injured seed	1600	94	90	4
Slightly broken	1600	82	66	16
Seriously damaged seed	400	71	9	62

Jennie Jones, Virginia:

Allium vineale (Bulblets). Material used came from screenings or from commercial field seed known to be 1937 grown. Tests were delayed until January, 1938. Bulblets had become dry and many were shriveled. Forty tests were made, with varying but liberal numbers of bulblets in each. All types of injured to un-injured bulblets were used with better results at low temperatures; 10°C., constant, or 10° to 20°C., alternating temperatures, appeared promising. Practically all damaged bulblets failed to germinate, though this may not have been the case earlier in the season. Un-injured bulblets, in spite of their dryness, germinated as high as 73%. In view of the new definition of weed seeds in Rules for Seed Testing, "That undeveloped and badly injured weed seed, including noxious weed seeds which upon visual examination are clearly incapable of growth, should be considered inert matter and not weed seeds", it seems advisable to determine whether or not we can tell upon "visual examination" whether or not the damaged or undeveloped weed seeds will germinate. It was our intention at first to separate perfect bulblets from damaged ones, also showing different degrees of damage. We believe now, however, that the first step should be to determine the proper temperature for the germination of perfect bulblets and later to experiment with those which are damaged.

W. H. Wright, Ottawa, Canada:

Ambrosia artemisiifolia or ragweed

2885 Unhulled achenes	Germinated 35.5%	
	Un-germinated) remaining fresh)	63%
1790 Hulled seeds apparently sound	Germinated 8%	
	Ungerminated) remaining fresh)	4%

376 Hulled seeds apparently injured Germinated 0

Un-germinated) 0
remaining fresh)

The un-hulled seed were pre-chilled at 5°C. for 14 days and germinated for 40 days in light at 20-30°C.

Agropyron repens or couch grass.

91 Hulled Caryopses Apparently Sound	Germinated	87%
69 Hulled Caryopses Doubtful	"	73%
800 Hulled Caryopses Injured, not expected to germinate	"	20%
600 Un-hulled Caryopses	"	95%

The Un-hulled caryopses were pre-chilled for 2 days at 5°C.
The complete test lasted 21 days in light at 20-30°C.

Setaria viridis or green foxtail

1200 Un-hulled caryopses	Germinated	75%
1200 Hulled caryopses apparently sound	"	48%
118 Hulled doubtful	"	23%
219 Hulled injured, not expected to germinate	"	3%

The un-hulled caryopses germinated between blotters 9 days at 20 to 30°C. The hulled caryopses in light, 11 days 20 to 30°C.

In analyzing these reports, we have arrived at the following conclusions:

They represent a direct effort on the part of the Association to arrive at a possible solution of a very important phase of its responsibilities with respect to determining the value of weed seed.

Cooperative members have given and doubtless will continue to give liberally of their time in order to solve this problem.

The information contained in these reports confirms the results of other investigators in that badly injured weed seeds have their vitality much reduced below that of un-injured seeds.

The data are not conclusive. More tests need to be conducted on seed of known ages and of different degrees of injury and maturity.

More thought should be given to finding out first, how to germinate un-injured seeds and what their optimum requirements are as to temperatures, substrata, etc. With this knowledge we can then proceed with more accuracy in testing injured and immature seeds.

This work should be continued at least to a point where it will aid the purity analyst in the interpretation of the new weed seed definition.

5. Value of hard seeds in legumes - W. O. Whitcomb.

No work was done on this subject, because of time involved in publishing the back numbers of the Proceedings.

6. Study of use of sand as a substratum for seed germination - C. W. Leggatt.

The results of this study are given in the foregoing report for Region No. 3.

7. Rules - E. H. Toole, W. H. Wright, and M. T. Munn.

"Rules and Recommendations for Testing Seeds", as adopted by this association on August 27, 1937, have been published both in the 29th Proceedings of the Association and as United States Department of Agriculture Circular 480. Any difficulties which may arise in the actual use of these rules should be called to the attention of the Association in order that changes may be made where desirable.

There has been much discussion of the need of adoption by the Association of a tolerance for the rate of occurrence of noxious weed seeds. It has been found by several workers that, provided the seed lot is well bulked, the actual variation in rate of occurrence of seeds of noxious weeds in successive samples follows closely the theoretical distribution.

A table has been provided in the "Rules and Recommendations for Testing Seeds", showing the theoretical maximum range to be expected in a sample for various actual rates of occurrence and for various degrees of certainty. From general considerations, a reasonable degree of certainty would seem one which allowed a maximum range that would not be expected to be exceeded more than once in 20 trials. It is suggested that such a tolerance be applied in actual practice and given a year's trial to determine whether it is practicable in actual use.

Provisional noxious weed seed tolerance. The values in Table 2 of "Rules and Recommendations for Testing Seeds", in the column "20 trials" for the corresponding value under "given or expected number" are proposed as tolerances for rate of occurrence of seeds of noxious weeds. In the use of this table, the rate on the label should be revised to the basis of the amount actually examined to determine the number to be consulted in the "given" column. Then, the tolerance would allow as a maximum number in the amount examined the corresponding number in the column under "20 trials".

Examples and discussion. A sample of red clover seed is labeled 90 dodder to the pound. An examination has been made of 50 grams, the amount specified in the Rules as the minimum to be examined for noxious weed seeds in red clover. A rate of 90 per pound is approximately 10 per 50 grams. If not more than 16 dodder seeds have been found, the label would be considered within the provisional tolerance. It may seem desirable to examine another 50-gram portion. Then, for the total of 100 grams examined, 20 would be the "given" value and the maximum number allowable within the tolerance would be 29.

It should be noted that in the use of this tolerance, the degree of certainty or the probability remains the same (1 in 20 trials), but the proportional tolerance varies with the expected number and, therefore, for any given sample, with the amount examined. For instance, in the above example of a sample labeled 90 per pound, the maximum limit is 16 for 50 grams examined; had 100 grams been examined, the limit would have been 29, but had only 5 grams been examined, one would have been expected and four would have been the maximum limit under this tolerance. When these maximum limits are calculated at rates per pound they become 360, 144, and 131, for examination of 5, 50, and 100 grams respectively, for the same sample labeled 90 per pound.

All will agree that five grams is too small an amount to examine; however, when a lot of red clover seed is labeled 9 dodder per pound, only one would be expected in the 50 gram sample specified as the minimum quantity to be examined.

A maximum limit of 4 in 50 grams would be allowed by the tolerance, or at a rate of 36 per pound when labeled 9 per pound. If 500 grams were examined, the maximum limit would be 16, or at the rate of 15 per pound with a label of 9 per pound.

From these examples, it should be clear that in order to keep the proportional tolerance low enough to be a reasonable protection to the purchaser, an amount should be examined, where practicable, that would give an expected number of 10 in the amount examined. The examination of an amount such that 20 would be expected will reduce the proportional tolerance appreciably, but the examination of a larger amount will reduce the proportional tolerance very little and would not seem to justify the increased work.

8. Handbook - E. Brown and W. H. Wright

In order to make a definite start at collecting material for the Handbook, and also to find out from the members of the Association what type of paper should be included, the Committee wrote to certain members for contributions. The following four papers were received in time to be mimeographed and sent to every member laboratory before the Annual Meeting: -

The Seed Collection	H. Sifton
The Size of the Working Sampled for Purity Tests.	C. W. Leggatt
Sampling.	Wright & Leggatt
How Accurate is a Test?	Leggatt

Three other papers were received too late to have mimeographed before the Annual Meeting. This, however, will be done in the near future. These are: -

The Objects of a Purity Analysis.	W. O. Whitcomb
The Technique of Purity Analysis.	Miss E. F. Sirrine
The Identification of Seeds.	Miss A. F. Musil

The Committee recommends that between now and the next annual meeting as many papers on various phases of seed testing be prepared as is possible; these to be memeographed and sent to the membership for criticism and suggestions; and, further, that the next annual meeting be devoted almost entirely to a discussion of these papers and the Handbook.

Summary

The activities of the Research Committee for 1937-1938 have been somewhat extensive, as the report shows. The major objectives have been to (a) determine the extent of variability in tests among different laboratories, (b) investigate the causes for extreme differences, and (c) attempt to develop standardized and uniform techniques in the testing of grasses and other crop seeds. It is

believed that the report shows definite progress along several lines and suggests leads which may result in improvements of value to both seed analysts and the seed industry.

In the light of the data accumulated as well as the experience of the past, the committee desires to present some recommendations for the future policies and activities of the Research Committee as well as to seed analysts regarding their responsibilities in the development of standardized and uniform techniques for seed testing.

Recommendations

The Research Committee recommends that:

1. The Association record again its conviction that referee testing affords the best means for analysts to (a) meet on common grounds (b) compare the results of their testing methods, and (c) study the reasons for differences. Every analyst, therefore, should so some referee testing regardless of limited facilities and experience.

2. More analysts avail themselves of opportunities for working on problems in seed testing in which two or more laboratories can take part. This can be done to advantage through the Research Committee.

3. The Research Committee adopt as one of its major functions a program of applying the results of fundamental research to seed laboratory practice. New techniques in seed analysis, new leads which appear to have merit should be investigated by the committee and recommendations made after adequate trial.

4. The Association through its Research Committee encourage laboratories, which are equipped, to investigate any phase of seed research in which one or more analysts may be interested.

5. The Research Committee cooperate with the Legislative and other committees in helping to solve problems on which the Research Committee has or may obtain information.

6. A sub-committee of analysts trained in plant pathology be organized to study the application of phytopathological techniques to seed laboratory practice. The laboratories in Ottawa, Iowa, Massachusetts and New York should be represented and others added in due time. Chairmanship of the sub-committee should be rotated annually.

Acknowledgments

The extent of the activities of the Research Committee is the result of the extensive and whole-hearted cooperation given by official and commercial analysts, regional chairmen, members of sub-committees, the President and Executive Committee of our Association, and the Seed Trade. The thanks of the chairmen are gratefully extended to all.- R. H. Porter, Chairmen.

REPORT OF THE LEGISLATIVE COMMITTEE

Perhaps it might be well at this time to review somewhat the proceedings at Washington last summer, which concern the Legislative Committee.

Mr. Brown offered the statement that the Coffee Bill considers the minimum label requirements for inter-state shipment, but does not consider the prohibiting of shipments into a state of seeds which are not salable within that state. It was suggested by Mr. Elliott that the Legislative Committee consult with Mr. Brown concerning compulsory labeling.

Mr. Burke submitted his report on the Standards for Vegetable Seeds which showed quite a variation between the now existing standards, to which reference will be made later. Mention was also made concerning tolerances for these standards.

Dr. Haskell recommended the study of certification as to vegetable seeds and discussed the labeling of treatments used in treated seeds.

The question was raised by Mr. Munn and Mr. King of the Northrup, King Company as to whether the vendor of vegetable seeds is precluded in the case of packet seeds from putting on germination standards, even though such seeds are above the standards established by the state and also whether it would be advisable to consider another sub-section, such as follows: "It shall be provided that the statement in Section B (2) shall not preclude the vendor from stating the actual germination, subject, however, to any tolerance here and after provided for by the Rules of Seed Testing adopted by the Association of Official Seed Analysts of North America."

Mr. Whitcomb of Montana discussed the advisability of including a noxious weed statement within the labeling requirements for vegetable seeds and referred to Wild Morning Glory and Field Bindweed in beet seed. Mr. Stone also referred to this matter as a possible method of dissemination of noxious weed seeds and referred to Field Bindweed now serious in southern Wisconsin.

In this connection the writer would like to refer to page 42 of the Extracts of the Minutes which has provided for a noxious weed section in the proposed Federal Seed Legislation and to Mr. Elliott's further remarks concerning a list of noxious weed seeds in garden and lawn seed of Canada.

In addition to the material referred to in the minutes, is the possible question of tolerances for the number of noxious weed seed which have been provided for in at least one state. This may be more properly a function of the Research Committee, yet it should be considered in the law. Does the establishment of a standard for vegetable seeds take into consideration the applying of the rules for tolerances provided for in the Rules for Seed Testing?

In response to my letter to the members of the committee asking for suggestions, the following have been received:

Mr. Snyder suggests some study of the sale of flower seeds as well as treated seeds for seed borne diseases; this matter being somewhat in keeping with Dr. Haskells suggestion.

Mr. Stahl refers to a statement in the Montana law compelling retesting of seeds for germination after a 90 day period, and believes that information concerning the advisability of such regulations might materially aid in law enforcement.

Mr. Goss suggests the following: "With reference to your request for additional subjects for discussion, I have been thinking for some time that enforcement would be simplified and practically the same end accomplished with our For-

age Crop Seed Law if the requirements for percentages of purity were omitted, its place on the tag being taken up by actual planting value of the seed, or, pure live seed and the number per pound of noxious weed seeds and the pure seeds capable of growth. It appears to the writer that this would convey to the planter all the information now required and remove the necessity of making detailed analysis to determine whether or not the percentage of pure seed was stated within the limited tolerance."

Mr. Allen suggests some revision of the Uniform Field Seed Law, and for one consideration suggests a definition of variety as well as the percentage of varietial purity be required and perhaps the advisability, in the case of lawn grasses, of not requiring the germination percentages where such mixtures contain more than two kinds of seeds and offers the further suggestion relating to trees, flower seeds, and shrub seed as a part of a uniform law.

Mr. Davidson, likewise, suggested a consideration of germination standards, labeling of noxious weeds in vegetables, especially in large containers and some revision of the Uniform Seed Law in keeping with present trends of seed legislation and the newly adopted Rules for Seed Testing. Also, the suggestion that possibly work on the uniform label, which has been fostered by the Commissioners of Agriculture, might be considered.

Many other valuable suggestions were received from members of the Association, but the committee members felt that it would be impossible to carry on even a small portion of the material into such form as could be presented at this meeting.

The report of Mr. Goss, which has been combined with my report, is as follows:

The project which was undertaken by Mr. Goss and myself was to collect information from various states on actual germination tests made over as long a period of years as such information was available. Mr. Goss communicated with the states West of the Mississippi and the writer took over the responsibility of collecting information East of the Mississippi. It so happened that the reports of Mr. Goss were forwarded to me, therefore they have been compiled into one summary.

In addition to the summary of vegetable seed tests, which it was hoped would give some idea as to why certain standards were selected by certain states, the existence of vegetable seed laws in all the states have been summarized. This was a continuation of Mr. Burke's report of last year and included those states which enacted seed laws recently. Last year the Association was presented with standards and this work has been extended to include all states which enacted seed legislation or have formed any opinion on the matter.

The next step was to convert the material submitted by the various states dealing with bona-fide tests into a summary in order to determine just what the results have been over a period of years. Since many states do not have vegetable seed laws, it is to be expected that little information is available on vegetable seed tests. Again, the states which recently enacted Vegetable Seed Legislation, generally did not have much information to date and, therefore, the summary in general represents the experiences of those states which have legislation for a number of years, such as Virginia, and California. The average results have been compared to the average standards.

It is possible that these averages are necessarily low averages for the reason that they include seeds which may have been carried over for several years or have been questionable lots which have been referred to the seed laboratories

for final determination.

As stated by Mr. Holmes, "Correct standards can be based only on seeds of known age and history of each variety." However, but few data of this kind are available, and therefore probably do lower the standards considerably. In some cases it is stated that the better seedsmen consider the standards below the standards of germination they are selling. Yet at the same time, many of the seedsmen hope that the standards will be within that range of tests which will not unduly hamper the marketing of seeds.

Another questionnaire which was submitted to the states, indicated that practically all the states which replied felt that the general Rules of Tolerance should be applied to vegetable seed and the general concensus of opinion was that the standards to be established should take into consideration the maximum tolerance for each kind of seed and then prohibit the application of further tolerance below the established standards.

The committee as a whole feels that without further investigation concerning the experiences of other states and reports from Canada that it would not be advisable to adopt standards at this meeting.

The members of the committee wish to express their appreciation for the splendid cooperation given by the various states in all phases of the legislative program. -C. N. McIntyre, Chairman.

THE OCCURRENCE OF WEED SEEDS IN COMMERCIAL VEGETABLE SEEDS

C. A. Stahl

For the Legislative Committee

In the accumulation of information relative to the occurrence of weed seeds in vegetable seeds with the possibility of recommending regulatory legislation, it at once became apparent that the problem was somewhat complex and considerable research in determining the frequency of weeds in vegetable seeds would be necessary. Letters were sent out to a small, but representative, group of seedsmen as well as many state laboratories with the thought of getting the reaction of these groups as well as such information as would be available for use in this report.

The reaction of the seedsmen to the proposal of enacting legislation was for the most part against the idea and the returns indicated that the subject had been a matter of discussion before replies had been made. The reaction of the State Laboratories, for the most part, indicated very little, as only one laboratory had well defined ideas favoring the proposal and basing their decision on research work actually done on the problem as presented. It was surprising how few of the laboratories had ever done any work on this problem. Even laboratories that had acted as the enforcing agency for vegetable seed laws, for reasons of their own, had failed to make a study of the weed seed content. The response and willingness of the laboratories to cooperate was very gratifying.

The only publication available for immediate use was Bulletin 616, "Weed seeds found in vegetable seeds" published by the New York Experiment Station in 1932. While the material in this bulletin would be at least six years old at this time, Mr. Munn assured the writer that in all probability present-day conditions would be essentially the same. Therefore, this information was used in making up this report.

For convenience and study, three tables of data have been compiled as follows:

1. Noxious weeds in the United States arranged according to their frequency by states.
2. Weed seeds in 3,800 samples of vegetable seeds arranged according to their frequency.
3. Weed seeds in 1,500 samples of Agricultural seeds arranged in the order of frequency.

Table 3 is for comparison with Table 2. In Table 1 it will be noted that dodder is the "No. 1 noxious weed" in the United States having been designated as such by 45 of our states. Canada thistle follows as a close second, and these two are followed by quack grass, mustard, and buckhorn. Out of a total of 60 weeds, only 30 have been designated by as many as four states as noxious. Only 15 are noxious in 10 states. Therefore, it would appear that in recommending uniform legislation only those weeds in the fore-part of this table need receive our consideration, and the balance of the list would be a problem for the individual states. In comparing Table 1 of noxious weeds with Table 2, it will be noted that No. 1 weed (dodder) occurred in only three samples of vegetable seed, No. 2 weed (Canada thistle) occurred in only one vegetable seed sample. No. 3 weed (quack grass) occurred in only one sample of vegetable seed.

In comparing Table 1 with Table 3, it is at once apparent that the weeds in the fore-part of Table 1 are also to be found in the fore-part of Table 3. This, of course, is to be expected as the weeds in Table 1 have been so designated due to their presence in agricultural seeds rather than vegetable seeds.

Up to this time, additional information which is being accumulated by the Ohio and Wisconsin laboratories has not arrived, but from the information at hand it is apparent that the only weeds now designated as noxious that appear with any great frequency in vegetable seed stock are the Brassicas, and they appear to the extent of 7.6% of the samples examined. While the Ohio, Wisconsin, and Michigan reports might change the viewpoint, and it is fully realized the limited scope of the present work and that other workers might arrive at different conclusions, it would hardly seem advisable to make definite recommendations for legislation at this time; at least until more information can be assembled.

My conclusion at this time is that, while the need for legislation is not great, it would not work any great hardship on those seedsmen who are trying and succeeding in placing quality seed upon the market. The Federal Seed Bill, now before Congress, may to some extent fill the need for legislation. In the meantime, each state should have some effective measures for taking care of lots of vegetable seeds carrying excessive amounts of weeds found to be a menace in their locality or state.

TABLE 1

WEEDS WHICH HAVE BEEN DESIGNATED BY THE VARIOUS STATE SEED LABORATORIES AS BEING NOXIOUS, TOGETHER WITH THE NUMBER OF LABORATORIES FOR EACH.

Weeds	Number of laboratories	Weeds	Number of laboratories	Weeds	Number of laboratories
Dodder	45	Frenchweed	7	Cocklebur	2
Canada thistle	42	Bermuda grass	7	Butter and eggs	2
Quack grass	36	Russian knapweed	6	Burdock	2
Mustard	28	Chicory	6	Bull thistle	2
Buckhorn	19	Spurge	5	Blue weed	2
Corn cockle	18	Horse nettle	5	Wiregrass,knotgrass	1
Wild oats	17	Hoary cress	5	Yellow trefoil	1
Bindweed	15	Crabgrass	5	Whorled milkweed	1
Johnson grass	15	Whitetop	4	Tievine	1
Wild garlic	14	Puncture vine	4	Watercress	1
Dock	14	Chess,cheat	4	Scotch thistle	1
Sow thistle	14	Yellow star thistle	3	Prickley lettuce	1
Wild carrot	12	Poverty weed	3	Poison hemlock	1
Sheep sorrel	10	Cats-ear Dandelion	3	Lambs quarters	1
Ox-eyed daisy	10	Bull nettle	3	Hop clover	1
Hawkweed	9	Wild barley	2	Ground cherry	1
Plantains	8	St. John's wort	2	Goat grass	1
Nutgrass	8	Ragweed	2	Galinsaga	1
King devil	8	Darnel	2	Carelessweed	1
Russian thistle	7	Creeping mallow	2	Camelsthorn	1

TABLE 2

RATE OF OCCURRENCE OF WEED SEEDS IN 3,800 SAMPLES OF VEGETABLE SEEDS.

Weed Seeds	Number of Samples	Weed Seeds	Number of Samples	Weed Seeds	Number of Samples
Mustard	288	Cress	7	Dead nettle	2
Wild buchwheat	174	Vipers bugloss	6	Buttercup	1
Lambs quarters	162	Yellow trefoil	5	Canada thistle	1
Cleavers	117	Sticktight	5	Catchfly	1
Ladys thumb	96	Marsh elder	5	Mouse-ear chickweed	1
Pigweed, rough	95	Hoary alyssum	5	Clinquefoil	1
Nettle-leaved goosefoot	76	Dandelion	4	Cranesbill	1
Pigweed, tumbleweed	74	Mallow	4	Dandelion, fall	1
Field bindweed	67	Mayweed	4	Flax, false	1
Pigweed	62	Ragweed	4	Frenchweed	1
Chickweed		Scentless, camomile	4	Hares ear mustard	1
(Stellaria media	46	Spurge, sun	3	Hawkbit	1
Barnyard grass	45	Spurge (Euphorbia spp.)	3	Hedge nettle	1
Foxtail, green	31	Picris, hawkweed	3	Loosestrife	1
Knotweed	29	Mallow(Malva parviflora)	3	Ox-eye daisy	1
Labiatae spp.	29	Chickweed (Stellaria		Pennyroyal	1
Dodder, field	28	gramineae)	3	Peppergrass, apetalous	1
Pimpernel	26	Bladder ketmia	3	Plantain, Rugels	1
Picris	23	Bull thistle	2	Quack grass	1
Sow thistle	21	Cockle, corn	2	Sage	1
Saltbush	17	Corn salad	2	Sheep sorrel	1
Pennsylvania knotweed	17	Crabgrass, small	2	Shepherds purse	1
Black nightshade	14	Field camomile	2	Slender chess	1
Foxtail, yellow	13	Fireweed	2	Spreading panicum	1
Spurry	12	Morning glory	2	Spurge	1
Poppy	12	Mustard, wormseed	2	Vervain	1
Purslane, pussley	10	Pale persicaria	2	Vervain, blue	1
Pigweed, prostrate	9	Peppergrass, field	2	White hoarhound	1
Crabgrass, large	8	Peppergrass, wild	2	Wood sage	1
Plantain, broad-leaved	7	Prairie birds-foot			
Plaintain, buckhorn	7	trefoil	2		

TABLE 3

RATE OF OCCURRENCE OF WEED SEEDS IN 1,500 SAMPLES OF AGRICULTURAL SEEDS

Weed Seeds	Number of Samples	Weed Seeds	Number of Samples	Weed Seeds	Number of Samples
Buckhorn	704	Catnip	15	Frenchweed	3
Pigeon grass	388	Mayweed	13	Field camomile	3
Ragweed	314	Shepherds purse	13	Tarweed	3
Catchfly	281	Russian thistle	13	Dandelion	3
Dock	266	Mallow	12	Black nightshade	2
Wild carrot	228	Heal-all	11	Hoary alyssum	2
Lambs quarters	218	Crab grass	11	Fireweed	2
Sorrel	200	Chickweed	11	Sand rocket	2
Quack grass	193	Wild oats	10	Small rush grass	2
Yellow trefoil	123	Sleepy catchfly	10	Field speedwell	2
Canada thistle	96	Dodder	9	Horse weed	2
Field cress	72	Nerved manna grass	9	Slender chess	2
Ladys thumb	69	Nettle	8	Darnel	2
Cinquefoil	60	Cats ear	8	Sticktight	2
Rugels plantain	56	Marsh foxtail	8	Spurry	2
Plantain	54	Smart weed	7	Yellow alyssum	2
Small seeded false flax	47	Three seeded mercury	7	Blue weed	2
Spreading orache	46	Bull thistle	7	Slender fescue	2
Mouse ear chickweed	44	Chess	6	Serradella	2
Yellow foxtail	43	Chickory	6	Sow thistle	2
Charlock	36	Mint	6	Cranesbill	1
Sedge	36	Dragons head	6	Black mustard	1
Yellow rocket	31	Sweet vernal grass	5	Milkweed	1
Yarrow	29	Velvet grass	5	Poverty grass	1
Witch grass	25	Brown-eyed susan	4	Brown knotweed	1
Pigweed	24	Cockle	4	Spreading amaranth	1
Wild buckwheat	24	Saltbush	4	Lesser starwort	1
Barnyard grass	21	Rat-tail fescue	4	Vervain	1
Ox-eye daisy	19	Knotweed	4	Meadow soft grass	1
Hairy panicum	19	Evening primrose	4	Birds-foot trefoil	1
Pepper grass	19	Indian mustard	3	Marsh elder	1
Wormseed mustard	17	Crested dogtail	3	Bladder ketmia	1
		Buttercup	3	Toad rush	1

VARIETY AND VARIETAL PURITY

L. N. Allen

For the Legislative Committee

In studying the trend of modern seed legislation, special consideration has been given to the question of requirements for varietal designation. The study shows that every reply to the questionnaire stated as a requirement of the Seed Law that the common name be given. Eighteen replies showed that the variety was required and 13 that the variety was not required, although 31 of the 35 answering thought that the variety should be required. Three stated a definition for variety, while 32 had none. Of these, 16 permit the use of the word "Unknown" when the variety is not known, while four do not. They, of course, may sell seed without a statement of the variety.

In connection with this study of varietal requirement, the question was raised as to whether the percentage of purity given on the analysis tag applies to the kind only or to the kind and variety. Twenty-six replies indicated that the percentage of each variety in a mixture should be labeled and five indicated not. Eighteen thought the percentage of variety should be labeled separately on the analysis tag, while 17 did not. Thirty replies indicated that variety names should be required on all kinds of seed, whether garden or field, while two indicated not.

In order to determine whether any control work was done with varieties, the question was asked whether field testing was done to determine the correctness of labeling as to variety. Fourteen states are testing varieties of field seed in the field, while 18 are not. Nine are testing varieties of garden seed and 19 are not. Four are testing varieties of flower seed and 21 are not. The testing is carried on by means of test plots conducted by the laboratory itself, in nine instances and at the Experiment Station in 16 instances.

Further investigation shows that 11 replies indicate that prosecutions have been carried on in connection with misbranded varieties of field seed, while 22 indicate not. For misbranding garden seeds, four states provide for prosecutions, while 25 do not.

Only two states indicated that they require the germination percentage on each kind of seed in mixtures of three or more kinds. Twenty-three states indicated that the so-called "Special Mixture Clause" in practically all seed laws should be discarded and the germination percentage required on seeds occurring as mixtures in quantities of 5% or more. Twenty indicated that they would favor such a change in legislation, while two indicated not.

Special attention was paid to the question, - "Do you think labeling of the variety should be required? ----- and why?" The replies were unanimous that the variety should be required on all certified seed, at least. A seed is not a seed unless its identity is known. The adaptability of the seed to climatic conditions, soil types, and disease resistance was considered very important in this connection. The requirement was considered of value in preventing false claims, as an aid in helping seedsmen in many cases, as an aid in helping the farmer to secure definite varieties of seed, and as an aid in preventing false labeling or promiscuous coinage of names. It was further claimed that varietal names should be required because of the distinctness of varieties, and that it would tend to prevent false claims in verbal sales for the variety to be labeled

according to the law. On the other hand, it was considered as inadvisable because it would be impossible to determine the variety by examination of the seeds. This objection, of course, would be overruled where facilities are offered for varietal tests in the field.

The following definitions for variety were given: (1) "A variety shows a marked variation of a species", (2) "A variety is a special kind or strain", and (3) "A variety is considered as a registered and certified seed from a field-inspected crop".

Some of the reasons, given on the questionnaire, why the percentage of varietal purity should not be required as a separate item on the analysis tag are here given:

1. Because of the complication of inspection and supervision and of mechanical mixing.
2. The inspection of the growing field crop is impractical and such service could not be given to all growers.
3. It is a requirement that can not be enforced.
4. It is too indefinite.
5. Because it is desirable to have only a minimum number of items on the analysis tag.
6. The analysts can not always furnish the percentages when called upon.

Conclusion

As a result of this investigation, the committee believes the Association of Official Seed Analysts of North America should go on record as favoring:

1. The requirement that the variety name and kind be stated on all seed and that the word "Unknown" be not permitted where the variety is not known.
2. Requirement of a separate statement on the analysis tag for the percentage of varietal purity.
3. That the percentage of germination be required for each kind of seed in mixtures when such occur in excess of 5%.

REPORT OF THE PUBLIC SERVICE COMMITTEE

Work of this Committee has continued along lines followed during the previous year. The following titles of papers presented by the several members of our Committee suggest the nature of the projects on which we have been working.

1. Accepting a Recent Challenge of the Secretary of Agriculture.
   C. N. McIntyre

2. Advisability Versus Inadvisability of Establishing Standards for Agricultural Seeds.
   Marvin H. Snyder

3. Opportunity for Cooperation between the Extension Services and Seed Laboratories of the United States.
   F. A. McLaughlin

These papers are herewith presented:

ACCEPTING A RECENT CHALLENGE OF THE SECRETARY OF AGRICULTURE

C. N. McIntyre

Those of you who were present at the last meeting in Washington will recall the words of commendation by the Hon. Secretary of Agriculture, Mr. Wallace, for the work the Association is doing for the farmer and the agricultural interests in general. At the same time the inference was made that we were not getting this information over to the public in such a way that would make them conscious of our presence.

This seemed to the writer to be a challenge. Last evening, Mr. Wright in his talk on qualifications sounded another note in this direction when he said we must make our presence felt by establishing some qualifications for analysts, and make the public conscious of our presence.

The thought occurred to the writer that the collection of information as to publicity methods now in use in the various states would be of interest and might be the means of encouraging the use of more publicity, or, in other words, selling ourselves to the public--farmers, dealers, etc.

Replies to a letter addressed to the states were very few, yet interesting. Some states indicated that publicity was not desired because the laboratory was already taxed to capacity. Some states expressed the viewpoint that not much was being done but hoped for more. Others seemed to have taken an active part in their state.

Some of the methods used are as follows:

(1) Letters to dealers telling of the service by the laboratory.
(2) Posters.
(3) County Exhibits.
(4) News releases -- most effective.
(5) Radio.
(6) Selling of labels
(7) Mailing copies of rules and regulations to seedsmen and county agents.

(8) Trade Journals.
(9) Extension Bulletins on noxious weeds, hard seeds, seed-borne diseases, use of disinfectants on seeds, wild flowers, control of weeds by spraying and cultural practices, etc.
(10) Market News Bulletins.
(11) Field Days.
(12) Association with Seed Improvement Associations.

It seems to the writer that the responsibility for selling the Association to the public is the most important function of the Public Service Committee. We should encourage all states to take an active part in this most important work. The suggestion has been made that the stronger states might assist weaker states through the Public Service Committee by supplying material and suggestions for general use. The Public Service Committee would then act as a clearing house for material at hand and keep in touch with all publicity methods in use. In some cases the material could be localized. In others, credit can be given. We would then encourage greater cooperation between state departments and seed laboratories.

The writer realizes that finances may be the basic cause for the limited work now done, but, if the Committee can and will, (with the assistance of the now active states and provinces) develop a department of publicity, it is the writer's opinion that there will be greater appreciation of the work, finances will be provided to carry on this work, and the Association will have accepted the challenge.

ADVISABILITY VERSUS INADVISABILITY OF ESTABLISHING STANDARDS ON AGRICULTURAL SEEDS

Marvin H. Snyder

The popularity of grades established by the United States Department of Agriculture on various agricultural products continues to gain momentum. The consumer is demanding certain standards of quality in the products he buys. He may not fully understand all the factors involved in establishing a grade, but when he purchases the top grade he may expect a quality products. There is a demand for the establishment of grades on seeds by various purchasing agents and individuals.

It is realized that a person cannot be a specialist in all lines. The question is often asked why there are not standards for seeds. It is well realized that the genotype of a seed cannot be evaluated by the phenotype, but there are certain qualities which can be evaluated, such as are usually covered when seeds are bought under specifications commonly employed by state and federal agencies in their purchases of seeds. The brands of seed companies are essentially grades. Is it possible and practicable for the United States Department of Agriculture to establish grades for our various agricultural seeds?

The object of this study is to attempt an answer to this question. In arriving at an answer a questionnaire was mailed to the official seed analysts of the various states, to 30 departments of agronomy, and to 12 commercial seed firms. The following table is a summary of the answers received to the question "Do you believe it possible to establish grades on crop seeds?"

	Yes	Doubtful	No.	Total
Official Seed Analysts	16	3	8	27
Departments of Agronomy	3	1	0	4
Commercial Seed Firms	1	0	3	4

The various departments of agronomy and commercial seed firms were either disinterested or undecided as to how to answer the questionnaire; only four departments of agronomy and only four commercial seed firms replied. Because of the limited returns received from these two groups, it does not appear that a sufficiently large number has been heard from to arrive at any conclusion as to how these groups feel towards the establishment of standards on seeds. No further comments will be made on the returns from the questionnaires from these two groups.

In answer to the question "List in order of importance the qualities of seeds you consider important and could be used in determining a standard", there were thirteen qualities listed and a summary of these follows:

	Number of returns showing						
	1st	2nd	3rd	4th	5th	6th	Total
Purity	9	3	2	1	0	0	15
Germination	4	4	3	2	0	0	13
Freedom from noxious weeds	3	2	1	2	1	0	9
Weed seed content	0	3	5	2	1	0	11
Trueness to variety	1	1	0	1	0	0	3
Soundness	0	0	1	0	0	0	1
Other crop seeds	0	0	0	1	1	2	4
Weight per bushel	0	0	0	1	0	0	1
Inert matter	0	0	1	0	1	1	3
Color	0	0	0	1	0	0	1
Adaptability	0	1	0	1	0	0	2
Seed-borne diseases	0	0	0	0	0	6	6
Pure live seed				1	1	0	2

From this summary, it appears that the qualities predominant in establishing standards should be purity, germination, weed seed content, and freedom from noxious weeds.

As previously indicated, there were eight returns from official seed analysts indicating that they did not feel it possible to establish standards for seeds, and there were three who were doubtful.

In answer to the question "List in order of importance the reasons why it is not possible to establish grades", there was one reason in general agreement: (1) It would interfere with our state laws. Other difficulties listed were: (2) There would be a pressure to change standards due to crop conditions, (3) there would be a tendency to work at the bottom of the grade, (4) a grade could not give sufficient information, (5) grades would be too artificial, (6) standards could not be the same for each year, (7) the heredity or genotype of a seed could not be evaluated in a standard, and (8) standards would not give credit to the producer.

The writer finds it necessary at this point to apologize for an error which appeared in question 4 of the questionnaire. The question should have been "Do

you feel that the establishment of grades on crop seeds is advisable?" Instead of the word "advisable", a typographical error was made and the word "available" appeared instead.

In conclusion, it appears that the majority of replies received to the questionnaire would indicate that the establishment of standards on crop seeds could be worked out.

OPPORTUNITY FOR COOPERATION BETWEEN THE EXTENSION SERVICES AND SEED LABORATORIES OF THE UNITED STATES.

F. A. McLaughlin

Every state, territory, and island possession of the United States has a highly organized Extension Service. Alaska, Puerto Rico, Florida, and Rhode Island are the only possessions which have no seed laboratory of any kind. It would therefore seem that because of the function performed by Extension, namely, carrying facts and information to the people, that both the Seed Laboratories and the Extension Services would profit materially by cooperative programs.

With this assumption in mind, your committee has contacted every Extension Service for information relative to existing programs in operation and to learn in what ways cooperation, when lacking, may be obtained.

The following discussion deals with existing conditions and procedures and will not attempt at this time to make recommendations. Project outlines have been obtained from each of the 51 Extension Directors contacted. These, with other approved methods in operation, will be reviewed at a later date and an attempt will be made to draw up a plan for suggested complete cooperation between the two agencies:

Twenty-three of the seed laboratories are conducted by State Departments of Agriculture; seventeen are under the jurisdiction of Experiment Stations and seven are operated jointly by the two authorities. In only one instance is a laboratory jointly maintained by the Experiment Station and an Extension Service.

Thirty-three laboratories are located in the same town as the Agricultural College thereby being geographically next door to the headquarters of Extension, which is usually in close relation or housed by the College. Although the laboratories, as shown, are under different authority the greater number are located in the same town with Extension facilitating exchange of ideas and planning of joint projects. However, location in another town or under other authority should not preclude the assumption that a cooperative program can be effected.

A survey of programs in operation shows that 28 of the Extension Services and two Experiment Stations are promoting the use of good seed by a Crop Investment Program. There are found to be 14 cooperative projects between Crop Improvement Leagues, Extension Services or Experiment Stations, with four Extensions conducting only a minor educational program. Forty of the Extension Services employ one or more of the following educational features: promote Crop Improvement Associations; conduct demonstrations, club meetings, and conferences; prepare exhibits; show educational films; give radio addresses and publish bulletins or circulars. Only eight Extension Services have no special methods.

Replies show 38 active Extension projects emphasizing the value of good seed. Thirteen have no projects of this kind though they may employ other methods.

Though many Extension activities are commendable and cover the field of seed interest very effectively, replies as to cooperation between Seed Laboratories and Extension Departments are illuminating. Fifteen report extensive cooperation, 16 ordinary cooperation, 10 no official relationship and 10 no relationship at all. Among the last 10 consideration must be given to the fact that some of the states have no Seed Laboratories.

Replying to the question asking if there is need for closer relationship between the Seed Laboratory and the Extension Service, eight answered in the affirmative and 38 in the negative. It would seem, therefore, that all but eight of the Extension Departments are either satisfied with present relationships, or they have not been made aware of obvious advantages in cooperating with the laboratories. There is evidence elsewhere in the replies that the latter assumption is correct.

We believe that most of the laboratories can profit by making the Extension Departments conscious of the service that they can render. We also believe that many extension programs will be more effective if worked out jointly with the laboratories. Twenty-eight Directors of Extension Services have sent us copies of their project outlines. We plan to recommend the use of many valuable methods suggested in these project outlines for more active cooperation between the extension Services and Seed Laboratories.

REPORT OF THE EDITOR OF THE NEWS LETTER

The editor of the News Letter is always called upon to make a report, but there is really not very much that he can say. It does, however, at this time give me a welcome opportunity to express in person my sincere appreciation of the whole-hearted co-operation (on which the Editor is so dependent) received throughout the year. We have never been seriously at a loss for copy (although from time to time having to appeal for it, as a reminder of such dependence) and have, with your help, distributed eight numbers in this womewhat shorter-than-usual association year. It is hoped that they have met with your approval.

In conclusion, sincere thanks are expressed for the opportunity of having served you in this capacity for a second term, but at the same time recall to your mind the old proverb about "a new broom". The editor fears that after two years, the bristles become sadly frayed, the strings gently expire, and, in short, the new broom is found to have become an old broom! It is therefore suggested that a new broom again might be an advantage. Seriously, however, the writer feels that it would be good policy to circulate the editor-ship of the News Letter among our members. It will give the individuals so honoured a rather rounded-out experience of the work of the association as a whole, and at the same time provide for the introduction of new ideas and new policies, resulting in a more useful and a better News Letter. -C. W. Leggatt, Editor.

REPORT OF THE COMMITTEE ON QUALIFICATIONS.

A questionnaire was sent out by the Committee in 1937, to the persons in charge of all member laboratories in an attempt to obtain information on the following subjects:-

1. What should be the qualifications of officers directly in charge of seed testing laboratories.

2. What should be the qualifications of analysts working in seed testing laboratories.

3. The equipment with which laboratories should be provided.

Thirty-nine laboratories replied. Some of these answered very fully. In a few cases the answers were somewhat meagre. Making a summary of the replies was not quite so easy as might be expected; however, we feel that the information given below accurately presents the opinions expressed by the members.

Qualifications for those Directly in Charge of Seed Testing Laboratories.

14 members consider post-graduate degrees necessary.
20 " " " " " desirable.
5 " " " " " unnecessary.

31 members consider university degrees essential.
3 " " " " , or their equivalent essential.
3 " " " " merely desirable.
2 " " " " unnecessary.

Some idea of the knowledge of botany considered to be necessary can be obtained from the following summary:-

Systematic botany	considered	essential	by	34,	desirable by 3.
Plant physiology	"	"	"	28,	" " 5.
Mycology or plant pathology	"	"	"	18,	" " 5.
Histology	considered	"	"	11,	" " 7.
Cytology	"	"	"	0,	" " 1.
Ecology	"	"	"	0,	" " 1.
Agronomy	"	"	"	2,	" " 0.
Statistical Methods	"	"	"	27,	" " 3.

These summaries indicate very clearly that practically all those replying to the questionnaire are agreed that university degrees are essential, as well as a very wide knowledge of botany; so wide a knowledge, in fact, that specialization leading towards post-graduate degrees would virtually be required. In other words, specialization in botany is necessary, with particular emphasis laid on taxonomy, plant physiology, plant pathology or mycology, histology, and statistical methods.

Qualifications for analysts working in seed testing laboratories.

15 members consider university degrees necessary.
17 " " " " desirable
21 " " high school graduation necessary.
24 " " knowledge of botany necessary.
3 " " " " " only desirable.

The number of analysts employed varies much.

33 laboratories employ permanent analysts (from 1 to 9).
5 " have no permanent analysts.
23 " employ temporary analysts during rush season (from 1 to 20).
2 " have no analysts to assist the man in charge.
8 " make use of students either as full time analysts or part time.

Unfortunately, it appears to be impossible to get trained analysts who are qualified to do the work on appointment. All training, with very rare exceptions, must be done in the laboratory after appointments are made; and so, unless these novices are employed early enough to receive training before the rush season, there must be considerable delay in getting out results on account of the necessity of checking the work of untrained analysts.

As the result of its investigation, this Committee considers it most important that the Association of Official Seed Analysts make a definite statement regarding the qualifications which it considers necessary for both officers directly in charge of seed testing laboratories, and for analysts working under direction. The Committee further considers that these qualifications should be published in the Proceedings, and that reprints should be sent to The Civil Service Commissions of each State and Canada. If there is no Civil Service Commission in any State, the reprints should be sent to the official or officials responsible for the maintenance of seed testing laboratories and for appointing the personnel employed therein.

The information obtained on equipment is summarized below:-

Equipment: The equipment used in the laboratories which replied to the questionnaire appears to be fairly uniform. One or two laboratories are certainly not sufficiently equipped for official work.

Again 39 laboratories sent in replies. An attempt has been made to summarize the results, as follows:-

Germinators, Dark.

39,laboratories use some type.
39,thermostatically controlled.
15,water cooled.
3,ice cooled.
12,mechanically cooled.
5,cooled,but method not mentioned.

The Minnesota type is most commonly used, and second the Kny-Scheerer. Special types are also used, such as the room-germinator used in Canada, the chambers used in Maryland, Richmond, Va., etc.

Twelve laboratories reported the use of mechanical refrigerators which have been adapted for germination purposes.

Germinators, Daylight	26 laboratories have some type. 22,thermostatically controlled 12,water cooled. 2,ice cooled. 7,mechanically cooled. 2,cooled, but method not mentioned.

Most of these daylight germinators are Minnesota or similar types with glass doors. Only the Canadian laboratories and one other report the use of Jacobsen Tanks. One or two have specially designed daylight germinators.

It is doubtful if the glass-fronted Minnesota type can really be classed as a daylight germinator in comparison with the tank-type.

Blowers.	35 laboratories have blowers. 7,Kny-Scheerer only. 11,Holland or Leendertz type. 3,both of these. 13,other types, or type not mentioned.
Mixers.	38 laboratories have mixers. These are mostly Boerner, New Improved Boerner, with Kny-Scheerer taking second place. 1 barrel rotary type is in use.

In the Canadian laboratories, motor-driven mixers are used for small seeds.

Balances.	23 laboratories have both torsion and analytical balances. 9,analytical only. 5,torsion only. 1,type not stated.
Microscopes.	19 both binoculars and high power. 16,binoculars only. 3,no microscope.
Mechanical Counters.	12 laboratories.
Diaphanoscopes.	8 laboratories.
Soil Sterilizers.	5 laboratories.
Ultra-violet Lamp	9 laboratories.
Culture Incubators.	2 laboratories.
Ice Box.	1 laboratory.

Greenhouse.	3 laboratories.
Special humidifying apparatus in germinators.	3 laboratories

It might prove helpful to certain laboratories if the Association prepared a list of apparatus which is considered essential for the proper operation of a seed testing laboratory. -W. H. Wright, Chairman.

QUALIFICATIONS OF ANALYSTS AND NECESSARY EQUIPMENT FOR SEED ANALYTICAL WORK

Recommendations of the Committee on Qualifications which were adopted by the Association of Official Seed Analysts of North America at their annual meeting at Guelph, Ontario, June 21-24, 1938.

It was moved and carried; that the following recommendations of the qualifications committee be accepted; that the recommendations be included in the Proceedings and distributed as separates to the heads of laboratories and correct officials in the various governmental agencies; that it is not the intent of the Association that these recommendations should cause the dismissal of persons who may be qualified as a result of past experience.

1. Because seed testing can fulfill its obligations to agriculture only if the work is on a sound scientific foundation which is based on a personnel with such training as will enable them to understand the broad significance of their work and to develop seed testing to meet changing conditions, therefore, this Association recommends the following as desirable minimum qualifications for those selected for positions in seed testing laboratories.

(a) Qualifications for those in direct charge of laboratories:

College graduation with broad foundation in biology, post-graduate work or equivalent experience furnishing training in systematic botany, morphology, physiology, pathology, and statistical methods. These educational qualifications should be supplemented by a thorough knowledge of methods of seed testing and some acquaintance with the production and marketing of seeds.

(b) Qualifications for analysts carrying on the actual work of seed testing:

College training in biology with a good foundation knowledge of systematic botany, plant morphology, and either plant physiology or pathology. Some acquaintance with statistical methods is desirable. The actual training in seed testing methods at present is available, for the most part, only in properly manned and equipped seed laboratories.

2. The committee also recommends that the following be considered as absolutely minimum equipment for satisfactorily carryong on seed testing work:

Suitable quarters with adequate light, hand lens, binocular, seed herbarium, analytical and torsion balances, divider, blower, and germination chambers capable of being maintained at the temperature or temperatures required for the seed to be tested. In addition to the aforementioned equipment, all seed testing laboratories should have the use of a greenhouse. This is especially true in the testing of certain lots of seeds which show weak seedlings in the usual laboratory tests.

3. The following additional equipment is desirable in laboratories carrying on at least an average amount of work:

Compound microscope, diaphanoscope, light germinator, cold chamber for pre-chilling seeds, vacuum counter.

REPORT OF THE CERTIFIED LABEL PLAN COMMITTEE

At the last annual meeting, a report (1) was presented by a committee which had been appointed to study a proposed certified label plan. This plan provided for the issuing of official certificates of inspection on seeds which are offered for sale and the standardization of laboratory equipment and procedure in seed testing work. A canvass of the membership of this Association showed that a majority did not favor the plan.

This year, the plan has been given further consideration by a somewhat larger committee, and it has been decided that the more desirable features of it can best be brought about by a comprehensive Federal Seed Act. If the provisions of such an act can be worked out with the needs of the states in mind and enforced in cooperation with the states, it is believed that it will result in a most satisfactory regulation of interstate shipment of seeds.

It is the unanimous opinion of the present committee that the standardization of laboratory equipment and the procedure in seed testing work can best be brought about through the efforts of the Research Committee and the Qualifications Committee, working in cooperation with the analysts and officials of the various laboratories who are experienced in the problems involved. The recent publication of the "Rules and Recommendations for Testing Seeds" will do much to bring about uniformity in our work. The Handbook on seed testing, which is now becoming a reality, will also provide much information of value to analysts and enable them to better interpret their results.

Another feature of our work which is deserving of special consideration in connection with the standardization of equipment and methods and obtaining greater uniformity in our work, is the "referee testing." No better method of bringing the seed analysts of the various laboratories of North America together on a common ground has been devised than that of working together on uniform lots of seeds and learning of the difficulties which are encountered and how best to overcome them. This same thought has been developed in other associations whose members are striving to test various kinds of products and materials in such a way that their results will be comparable and useful in the merchandizing and ultimate use of those materials. Examples of this are found in the testing of wheat for milling, flour for baking, commercial feeds to comply with state and provincial laws, and the testing of butter-fat in dairy products. We, as seed analysts, can profit much by becoming more familiar with the progress which is being made in these allied lines of testing.

Greater interest and a more active participation in seed referee testing is urged. The referee committee will do well to plan more carefully the work to be done and to so arrange it that definite problems can be solved and more beneficial results obtained. Likewise, the analysts will best further their individual interests and the interests of seed testing in general by a more active participation in the work. Every analyst should do some referee testing work if he is to keep abreast of the times and be able to cope with the problems as they arise from time to time. If this spirit of cooperation could be carried throughout the referee testing work, a better understanding among analysts would exist and much would be accomplished in the way of bring about uniformity in seed testing.

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(1) Proc. Assn. Off. Seed Analysts North America. 1937: 40-41.1938.

In conclusion, this committee urges a close cooperation between the various seed control officials in the administration of the Federal Seed Act and an active support of the work of the Research and Qualifications Committees of our Association, together with a better understanding of problems of analysts through referee testing, as a means of bringing about more proficiency and uniformity in seed control work. -W. O. Whitcomb, Chairman.

REPORT OF HISTORY COMMITTEE

A brief history of seed testing in the United States has been compiled and is ready for publication. Histories of seed testing have been sent in by all states. It has seemed to the committee that a condensation of the most detailed ones is desirable and this has been done. In a few cases material has been added to state reports in order to complete the record.

A directory of analysts active at the present time has been compiled and a list has also been made of the analysts which were formerly active.

The question has arisen as to the definition of eligibility for such lists. Some laboratories include among their employees a large number to whom specific or special questions are referred from time to time. These workers give the major portion of their time to other fields. Should their names be included among those active in the field of seed testing?

It is hoped that a history of seed testing in Canada with some account of the individual laboratories will be received in the near future. -Anna M. Lute, Chairman.

REPORT OF PUBLICATIONS COMMITTEE

At the last annual meeting, this committee made a report of progress; at this time we wish to make a report of some accomplishment and further progress.

In April, the published Proceedings of the meetings for the years 1930, 1931, 1932, and 1933, which were planographed in one volume, were distributed. This volume, which consists of 298 pages and contains two half-tone cuts and 14 line drawings, was published at a cost of $711.64 or an average per page of $2.39. This cost compared favorably with the best estimate received from any printing company, which was $1,142.53 or an average per page of $3.83.

It is worthy of note in comparing the cost of publishing by planographing and by printing that there are certain advantages in having such material as our proceedings, printed. Chief among these are the matters of proof-reading and cost of reprints. With the planographing process, it was necessary that the proof-reading be done by the committee, as the large master sheets, which were later to be photographed for reproduction, could not conveniently be sent to the various authors, whereas when the material is set in type it is customary to send the galley proof to each author. The cost of reprints when the material was planographed was $4.00 per 100 copies of four pages each, whereas this cost when the material is printed is about $3.00.

The 1937 Proceedings were distributed the latter part of April. This volume consists of 151 pages and contains six half-tone cuts and no line drawings. The cost of printing these proceedings was $654.45 or $4.33 per page. The lowest bid received from a planograph company for the job was $416.00.

This is an important and useful volume, as it contains the "Uniform State Vegetable Seed Law," "Germination Standards for Vegetable Seeds", and "Rules and Recommendations for Testing Seeds". Galley proof was read by the authors of the various papers and reprints of these papers were made available at $2.75 per 50 copies of 4 pages each, or $3.50 per 100 copies, without covers.

By ordering 1000 copies of reprints of the "Rules and Recommendations for Testing Seeds", it was possible to secure a price of $55.00 for the lot, with covers. A number of these reprints were ordered by laboratories and other copies are now available through the Secretary. Arrangements were made to have reprints of the rules, with special printing on the covers, made for the various laboratories at a nominal cost.

It is noted in the report of J. P. Helyar, who was Secretary of this Association in 1914, that the suggestion is made that the reports and papers which were presented at the meetings prior to that time, be summarized and prepared for publication. The committee is attempting to locate this material, and will give consideration to having it published.

A complete index for all of the Proceedings, which are now published up-to-date, is in typewritten form, and is being rechecked by the committee preparatory for publishing. Separate name and subject indexes have been made. The name index shows that a total of 223 people have been connected with our Association in some capacity during the past 29 years. The subject index, which has been rather carefully cross-indexed, consists of 25 pages of typed material. It is estimated that the complete index will occupy about 30 pages when published. The cost of publishing by the planograph method will be approximately $72.60 at $2.42 per page. If the material is set in type and printed the cost will be $120.00 at $4.00 per page. It would seem advisable to have this index planographed as proof-reading will not be a problem and reprints will not be required.

A word in regard to the value of and the interest attached to this index may not be out of place. Many things of interest, with which but few members are familiar, may be found in the published Proceedings. Among these are the following: Ten articles dealing with Federal seed legislation, 169 dealing with germination, 16 with identification, and 23 with apparatus. Four people have been elected as honorary members of our Association; they are W. L. Oswald, Karl Leendertz, E. J. Jenkins, and Robert Wier.

Recommendations - The experience of the past two years has shown the need for more thought and careful consideration in the writing of papers which are to be published. This applies not so much to the subject matter of the papers, although this is of great importance, as to the form in which they are written; this is especially true of tables.

It is suggested that authors of such papers examine the papers appearing in the recent numbers of the Proceedings and note the form which is used and the arrangement of the tables. The manner of writing citations of literature has received rather careful consideration during the past year, and the form used in the 1937 Proceedings is the one agreed upon. It will be desirable if this form can be followed in the future. - W. O. Whitcomb, Chairman

REPORT OF SUB-COMMITTEE ON SEED-BORNE DISEASES (1)

A committee of three members of this Association, functioning as a sub-committee of the American Phytopathological Society's regular committee on regulatory work and foreign plant diseases, has been active during the year, particularly along the line of keeping in constant touch with all developments having to do with the control and detection of seed-borne plant disease. New methods of detection and manuals for determination of seed-borne plant diseases will be announced shortly.

Members should be advised that steps are now being taken to appraise the disease-distributing possibilities of seed stocks through various dependable certification agencies. In such plans seed analysts should take a keen and active interest especially in so far as they may be called upon or have an opportunity to make practical determinations or investigations of the situation regarding the sanitary condition of the seed stocks being used each season. Members should also know that they have the support of the above named society in their efforts to so organize their laboratory procedures and personnel as to be able to deal effectively with the several practical plant-disease seed determinations. Furthermore, there is a rapidly growing sentiment that in preparing seed control legislation and facilities for seed stock control due consideration should be given to the possibilities of restricting, curtailing, or even prohibiting with utmost promptness the movement of definitely disease-infested seed stocks in so far as practical to do so, and in the same manner as that of weed-seed-contaminated seed stocks.

At the present time there is great need of a sense of appreciation and a recognition of the fact that there are many important seed-borne parasites and that their detection through definite laboratory procedure is possible and falls admirably within the realm of work of the modern seed testing laboratory or station. In a very practical sense every germination laboratory worker must appreciate the fact that every time he sets up a germination tests he may be dealing very definitely with plant diseases.

The sub-committee has been reappointed by the Society for the ensueing year and urged to continue their efforts and report at the next meeting. To the end that a report may be comprehensive and representative the committee welcomes suggestions. - Edgar Brown, G. A. Scott, and M. T. Munn, Chairman.

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(1) Sub-committee of American Phytopathological Society.

FUNDAMENTALS OF SEED CONTROL

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In the administration of a State seed law, problems appear from time to time, the solutions of which taken collectively determine the policy within that State. In the administration of State seed laws in many States, these problems appear in different sequence or in different form, or the solutions may differ and policies result which differ in their character.

We have for instance; (1) different interpretations with respect to varietal representations; (2) many ways of labeling to show the presence of hard seed; (3) apparently wide divergence in the processes determining which weeds are noxious; and (4) a wide range of methods showing the rate of occurrence of noxious weed seeds.

At the present time the solutions to problems in the administration of seed laws often take the form of regulations or legislation not in keeping with the proposed Uniform State Seed Law. This results in confusion and conflict. It suggests the need for discussing the details fundamental to seed law enforcement in the hope of adopting uniform policies which, if put into practice, would in the long run make the administration of the laws more effective. Experience in the administration of seed laws more effective. Experience in the administration of seed laws should be sufficient to make this possible. It is recognized that there are circumstances making it necessary that certain policies be different in the different States. In general, however, the States would rather conform to a uniform, if more effective, policy. Such a situation justifies the existence of an organization representing the interested agencies whose members attempt to unify the different policies, as far as possible, into one broad general policy or code. The Rules for Testing Seed and the proposed Uniform State Seed Law are results of such endeavors.

Recommendation of a policy is not always sufficient - otherwise the requirements for stating the rate of occurrence of noxious weeds would be consistent throughout the States. There is, however, a growing interest in seed control resulting in the formation of seed councils which will undoubtedly support sound seed legislation and regulation. They also will, no doubt, seek equipment and consider recommendations to make the enforcement of the laws and regulations more effective.

There is no organization of seed control officials to which one may look for recommendations involving details in seed law enforcement. Such organizations exist for feed control officials and for officials engaged in the administration of laws relative to foods and drugs. There is also no organization of fertilizer control officials. The Association of Official Agricultural Chemists, however, adopts definitions and interpretations highly useful in fertilizer control. even though its declared object does not include an effort to obtain uniform legislation and regulation.

A high percentage of our members are directly or indirectly engaged in seed control work. It has been one of the objects of this association to foster seed control legislation and regulation. The records show, however, that discussions of fundamental detailed problems encountered in seed control have been sporadic.

Review of the Proceedings indicates that fully 80% of the papers presented pertain to seed testing. This may be proper because regulatory measures can not be administered before it is possible to make tests. While we would admit the testing of seeds has not reached perfection, yet where personnel and equipment for testing are adequate, an orderly trade in seeds is possible.

Discussions relative to testing should not be reduced, but research and discussions fundamental to control should be increased. It seems it would be well to encourage control officials, either engaged or not engaged in seed testing, to take part in our discussions. This would insure that control agencies may be familiar with the technicalities of seed testing and the seed analyst familiar with the problems in control.

Careless reporting of purity tests where variety is involved; failure of the seed laboratory to distinguish between ordinary purity tests and a determination of noxious weed seeds; or failure to properly interpret germination causes misunderstanding and possible injury to persons for whom tests are made and makes enforcement of laws that control labeling in regard to variety, noxious weeds, and germination impossible. Failure on the part of the control agency to recognize the proper application of tolerances; failure on the part of the control agency to appreciate the effect of storage on germination; or failure to recognize that the analyst is confined in the examination for noxious weed seeds to a comparatively minute portion of the bulk results in unfairness to the analyst as well as to the seedsman. Such lack of understanding is not prevalent. It is cited merely to show the need for mutual understanding between those engaged primarily in seed testing and those engaged primarily in control. Such understanding will result when they discuss together matters of interest to one or the other or to both. From such discussions may evolve the adoption and publication of definitions, interpretations, or proposed regulations which are needed.

The Seed Analysts' Association should consider the following:

1. Noxious weeds appear to be determined as those prevalent within the State, those difficult to separate from other seed, and also those which are difficult to eradicate in the field. It seems that the latter should be used as a guide in determining which are noxious. An excessive list of "noxious weed seeds" hampers control of those most harmful.

2. The method of labeling to show the rate of occurrence of noxious weed seeds should be consistent with that prescribed in the uniform seed laws.

3. Labeling as to the rate of occurrence of noxious weed seeds per ounce raises the question as to labeling when the noxious weed seeds are found in an amount requiring labeling but at a rate less than one per ounce. It is suggested that the use of the word "trace" may be used in such instances if it is not advisable to show the rate of occurrence per pound.

4. In keeping with the newly adopted Rules for Testing Seeds, the requirement in the uniform laws that the label show the percentage of purity, should be changed to a requirement for the percentage of the kind of seed with a separate statement to show the variety. This would avoid the confusion with respect to whether the percentage of the purity refers to the kind or the variety stated on the label.

5. At the 14th meeting, in 1921, the Association voted to interpret "percentage of germination" to mean the actual germination plus the hard seed, but that the hard seed percentage must also be stated separately. At the 16th meeting, in 1923, the Association voted to interpret "percentage of germination" in

the seed laws to mean the percentage actually germinating, hard seed to be stated separately. According to recent surveys, this matter is treated in various ways. The Association should clarify this recommendation. If there is justification for the position taken by many that the total live seed should also be stated, it seems that the Association might also approve that procedure.

6. We are familiar with the possible confusion of what is meant by "hybrid seed corn". A definition acceptable to the International Crop Improvement Association is worded as follows: "Hybrid seed corn shall be deemed to be seed of the first generation of a cross involving one, two, three, or four different inbred lines of corn or their combinations". Would it not be well for this Association to recommend the adoption of such a definition in the administration of seed laws?

7. The application of tolerances used in seed testing to control requires familiarity with their intended scope. The recommendations of French at the 23rd meeting in 1930 should form a basis for consideration. Mr. French had then served as chairman of the legislative committee for 17 years.

8. The use of the word "free" may be construed in a number of ways. It seems that it should be based on the assumption that "free means none were found in a test complying with the Rules for Testing Seeds".

9. Fundamental to control is the securing of a representative sample. On the basis of research which has been made, it is quite evident that a long trier should be used instead of the chief or short trier. This matter is treated in the Rules for Seed Testing. It seems it would be well for the Association to recommend that the long trier with several openings be used in securing all official samples except those of certain bulky seed.

10. There has been much discussion with regard to random sampling, recently of popular interest in straw votes. This is a problem that faces the administrator of a State law when he sends inspectors in the field. It would be well were this Association in a position to make recommendations in this regard.

11. There is great variance in the nature of the forms used by inspectors and analysts throughout the many States. The Association suggests a uniform type of laboratory report in connection with the newly adopted Rules and Recommendations for Testing Seeds. It seems evident that certain forms may more nearly fit the needs than others. A study of these may result in helpful recommendations.

12. The official samples of seed are required for evidence in contests that may develop in seed control. If these samples are badly weevil eaten or otherwise damaged, their effectiveness as evidence may be materially reduced. It seems it should be the policy of all seed laboratories interested in control to retain samples, especially official samples, for a period of time that would be of value from the standpoint of control. This often extends over a period of two years. Facilities to provide cold storage are often lacking. A recommendation, however, would serve as a goal which seed laboratories should strive toward.

13. It has been stated that when a sample of seed is tested for germination the evidence of the test is destroyed. It seems that this may not be true were it possible to take photographs of the seeds in test before and after counting. Such a practice would be especially helpful with official samples and may also prove to be of assistance in the standardizing of interpretations of germinated seed.

14. Varietal determination from seed characters must be supplemented in control by identification by seedling or plant characters. This requires plant-

·ing in the field, a definite recommendation for which may well be made by this Association.

15. The making of moisture tests, a standard procedure in the grain trade, should be of equal if not more significance with seeds, because of the relation of moisture to germination of seeds in storage. It seems this Association should foster the increased making of moisture tests in seed laboratories and the use of containers which would make this possible.

16. At the 26th meeting, Miss Jones presented a paper on the methods of publishing the results of inspection. There are suggestions in her paper that it seems may be adopted as a uniform policy which would make the publications much more instructive.

If feasible recommendations could develop from discussions of these matters and be adopted uniformly, more consistent and efficient control would result to the great appreciation of the scrupulous seedsman as well as the farmer.

THE UNEXPLORED AVENUES OF CROP IMPROVEMENT

W. T. G. Wiener, Secretary-Treasurer
Canadian Seed Growers' Association

The title of this paper suggests an exploration trip into some of the by-ways of crop improvement which are placing a drag on the work. To do this it would seem proper to work from the known to the unknown, and it is my intention to divide the subject into two principal parts for the purpose of this discussion. First, we will deal with the present system of crop improvement generally used in North America, them with some of the phases which, in my opinion, are not at the present time receiving the attention they warrant.

It is not possible in the short time at my disposal to deal in detail with the various modifications of the general plan of crop improvement followed in the United States and Canada. In the United States, Crop Improvement Associations are organized within the respective states, each state following its own devices in the matter of details of operation. In Canada, we have one national key organization, the Canadian Seed Growers' Association. However, irrespective of minor differences in the matter of standards and the details of operation, all these organizations are fundamentally operating on the same general plan.

Thus the affiliation of these Crop Improvement Associations of the United States and Canada some 20 years ago brought into being the International Crop Improvement Association. The function of the International organization is primarily two-fold; (a) to provide a means of bringing the representatives of the different affiliated organizations together for the purpose of planning measures of common interest to crop improvement workers and (b), to coordinate and develop standard practices in so far as is possible. We are sometimes prone to take it for granted that everyone is familiar with what is generally meant by crop improvement and the functions of crop improvement associations.

In its broader sense, crop improvement may be defined as "The art and practices involved in the development and use of farm crops". This, you may observe, is a somewhat broader field than is normally considered as the field of endeavour of a crop improvement association. To the average farmer and to many technical agriculturists, crop improvement associations merely function to provide a supply of seed pure to variety and strain. True it is that this may be the principal activity of a crop improvement association. However, in developing seed that is true to name and variety, those entrusted with the management must keep closely in touch with the whole broad field of crop improvement. If we do not keep this contact, our work cannot completely serve the purpose for which it is organized. This is in my opinion such an important point that I propose to deal briefly with the manner in which a crop improvement association operates.

As I have already pointed out that the majority of crop improvement associations in North America are organized along fundamentally the same lines and have much the same purpose. I can best illustrate by dealing in some detail with the organization with which I am most familiar.

In Canada, we have one national organization. It is an incorporated body and enjoys all the privileges of incorporation as provided for in the Dominion Statute commonly referred to as the "Companies Act". The Association is managed by a board of 19 directors. Ten directors are elected in Annual Meeting from the membership at large and nine are nominated by the ministers of agriculture of the nine provinces. This provides the management of the Association with a complete

cross-section of official departmental opinion.

Technical and legislative bodies holding membership in the Canadian Seed Growers' Association through representation include; the Privincial Departments of Agriculture; the Dominion Department of Agriculture through the medium of the Experimental Farms System; the agronomy and horticultural divisions of six of our largest universities; several agricultural schools; the Dominion Rust Research Laboratory; and the Provincial Seed Farm of the Province of Quebec. The balance of our membership, 1,526 members for the year 1937-38, is made up of farmer seed growers, who in Annual Meeting hold the balance of power.

There is a unique relationship between the Canadian Seed Growers' Association and the Plant Products Division of the Dominion Department of Agriculture. The Plant Products Division is a branch of the Production Services of the Dominion Department of Agriculture. It is administered by an Assistant Director and is charged with the administration of The Seeds Act.

Through this Division, the Canadian Seed Growers' Association obtains an annual grant from the Dominion Government, and by this means is able to carry on its work. Because of this grant it would be expected that the Plant Division would hold membership in the C.S.G.A. Strange as it may seem, this is not the case. The reason, of course, is that registered seed is an official seed grade and in its administration of The Seeds Act, the Division avoids relationships which would question its authority as an impartial arbitrator. This is particularly important since it is through this Division that field inspection of registered seed crops is provided. The idea is to provide the greatest possible efficiency with the least possible outlay and duplication of services. The relationship between the two bodies is one of complete confidence, the Dominion Department of Agriculture recognizing and accepting without reserve the crop registration certificate of the C.S.G.A.

Through this Association, is thus provided the means whereby all of these interested groups meet to work out the problems involved in seed improvement.

The Canadian Seed Growers' Association accepts only outstanding varieties for registration and thus a good deal of study is given to the merit rating of varieties. In other words, registration is intended to signify the best to be obtained in variety.

A standing committee of plant breeders studies the merits of the varieties and recommends only those with a high rating. This committee is organized in four sections: Cereal Crops, Forage Crops, Horticultural Crops, and Tobacco Crops. This committee may, as the need arises, be convened either by section or as a whole. As a rule, this committee meets once each year.

The Plant Breeders' Committee includes in its membership all the plant breeders in Canada. In addition to its work with varieties, this Committee studies and recommends the safeguards and practices which are used by the membership of the Association in producing registered seed crops. These are commonly referred to as rules and regulations.

Between meetings of the Plant Breeders' Committee, the Appeal Board performs the functions of the Committee. However, this Board is only asked to act in instances of emergency. Furthermore, this Board is the final arbitrator in the matter of disputes between the Association and its grower members. The personnel of the Board includes the chairmen of the four sections of the Plant Breeders' Committee and three other plant breeders.

All crops approved as of the required standard are covered by a crop registration certificate. Approval is based on the field inspection report and upon

the pedigree of the stocks used by the grower member. In addition, due consideration is given to the facilities of the grower.

The field inspection service is provided by arrangement with the Plant Products Division of the Dominion Department of Agriculture. This has proved an excellent arrangement since it prevents needless duplication and provides impartial inspection.

With the issuing of a crop registration certificate to the grower of the seed crop, the responsibility of the Association ends in so far as that particular crop is concerned. The final processing of the seed for marketing under the registered seed grades provided for by The Seeds Act is done under the direct supervision of inspectors of the Plant Products Division. To protect the grade, registered seed is sold only in containers which are properly tagged and sealed by the Dominion Department of Agriculture.

I have dealt at some length with matters pertaining to organization of seed improvement work in an endeavour to show that the mechanics of operation are quite well understood. While crop improvement associations may experience many difficulties with these phases of their work, it is realized that the real problems to be met by the management of any association lie outside the mechanics of its practices. It is with some of these problems that I now propose to deal.

If we look for a moment at the management of crop improvement associations, we find that there is some dissatisfaction at not being able to limit or extend the functioning of crop improvement to fill the complete needs of the area to be served. Some complain of failure because of constant interference with the scheme through the activities of other bodies or through the acts of legislatures. This is to be expected because in operating a free-will organization under democracy in government we must realize that this very thing will happen. The peoples of the United States and Canada insist upon the principle of the greatest good to the greatest number. Whether this is always accomplished, is outside the realm of this discussion. The point I wish to make, however, is that too often the reaction of crop improvement managements to these conditions is to immediately take steps to obtain more legislation.

The legislation may be of two forms: (a) more stringent regulations governing the practices of its members or (b) governmental legislation; the object being to force somebody to do something. Whether this viewpoint is right or wrong I am not prepared to state. I do think, however, that considerable caution should be exercised in this matter, otherwise the costs of production services will ultimately become prohibitive.

We hear a great deal about the difficulty of getting the farmer to use good seed. The common cry is, "How can we get farmers to use this good seed after it has been produced very carefully and for the purpose of serving his best interests? Who does he ignore the plea that for his own good he should use the best possible seed?"

Many attribute price as the most outstanding factor influencing the farmer in the purchase of good seed. There is not the least doubt it is a major factor, but in my opinion it is not the all-important consideration. There is possibly a group of other considerations about which we have not concerned ourselves because to secure the necessary evidence involves considerable expenditure and crop improvement associations are notoriously short of funds. What these things are which inhibit the distribution and use of the best quality seed I do not know. Such work as I have done on the subject convinces me that there is a dearth of concrete evidence upon which to build, with the result that each of us holds his

own views on the subject.

In this connection, one might speculate upon the effect on the farmer of that oft repeated protest that he will use good seed if the price is right. You all know of many instances where thousands of farmers have bought fancy named varieties from speculating salesmen. Is there here a lesson to be learned? I think possibly there is, which in turn raises the question of "What is a right price for good seed?"

We may very well ask ourselves whether we have given sufficient thought and study to what good seed costs the producer and as to the price which should justifiably be paid for such seed by the consumer. Is it not logical to claim that seed below a certain price is likely to be a faulty article manufactured down to a price? In other words, are we applying business methods in our approach to the farmer?

The farmers, in my opinion, are just as keenly appreciative of clear-cut business practices as any other group of business men. Thus the question arises as to whether or not we spend too much time telling him what is wrong with his product after it has been grown and not enough about how to produce it well.

Many are prone to believe that legislation is the key to success. In this connection, have we first asked ourselves what effect general legislation and the official agricultural viewpoint have on the use of good seed? I do not mean seed and crop improvement legislation alone. We cannot afford to overlook the effect upon the use of good seed resulting from marketing legislation, weed control legislation, land utilization legislation and the recommendations of other agricultural groups not specially interested in crop and seed improvement. For example, two large alfalfa producing areas in North America have been eliminated from the production of high quality seed through the recommendations of stock breeders that sweet clover with alfalfa was the real thing from the stockman's point of view. It has, however, been found in one instance that the benefits from the use of sweet clover do not nearly compensate for the loss of revenue incurred through the change.

Weeds possibly take the largest single toll of all adverse factors entering into successful crop production. To effect control, many States and Provinces have provided weed control legislation. In seed legislation, we recognize weed seed control as a factor in every instance. With these weapons at our disposal we are often asked the question as to why weeds are still our major problem even in those areas where there is in force the most advanced type of legislation. In our seed legislation, we set up some very fine machinery and provide seed testing laboratories to determine the kinds and quantities of weed seeds that may be permitted in graded seed. We have capable analysts to do the work, and with it all we are often surprised to learn that farmers in general are not very sympathetic towards this type of legislation. The principal trouble with legislation in many instances seems to be that it would require two policemen on every farm to make it somewhere near effective. Consequently, some other solution must be found. To do this we may be obliged to look beyond our own sphere of activity and find out what the other fellow is doing that has a bearing on our problem.

How many of us interested in crop improvement and weed control measures have interested ourselves in the development of the better types of cleaning machines that would come within the means of the farmer? True, we have all tried to do what we could to educate the farmer to use the existing cleaning machinery, much of which, the best to be said of it is that it is inefficient. It may be that the men whom we should educate and control are the manufacturers and dealers

of cleaning machines. It may not be practical to do this but there are in it elements worth considering.

The response of the farmer to the analytical services provided is singularly interesting. It can probably be best shown by two questions frequently asked: (a) "How do you know my crop is not pure?" and (b) "Why can you not identify mixtures of varieties by examination of the seed?" We probably never will find the answer to the latter question, but if it could be answered in part it would do much to establish the confidence of the farmer in our work. It is admitted from the outset that this phase of the work calls for an intensive programme of research. It is therefore not properly the work of the service laboratory. The research laboratories are essential to progress and we should not overlook the possibilities of improvement in this field.

The work of the inspector of field crops is that of an analyst. His services in crop improvement are primarily to protect the guarantee of the Crop Improvement Association. With the imposition of definite minimum standards for varietal or strain purity, his work must be done as accurately as that of the seed analyst. However, between field inspection and the grading of the seed, there are many chances for mixing between varieties to take place. Here the point I wish to make is that it may be we are overlooking to some extent, the possibility of extending the means of positive identification of many varieties through the medium of examination of the seed.

Samples of seed that are trucked around from laboratory to laboratory are sources of annoyance and embarrassment. Many of these lots are doctored and mixed in an endeavour to meet grade standards. Thus, innocently enough, the report leaks out that two different opinions on the same seed stock. This militates against confidence in our work and is a matter of gravest concern to both the analyst and the managements of crop improvement associations. We who have had some experience in securing representative samples for analysis, realize that variations in sampling must occur. The farmer and the greater proportion of small seed dealers, however, do not appreciate the fact that the analyst is at the mercy of the methods employed by the person who draws the sample for analysis.

In view of the fact that the analyst is dependent upon some uninformed person to draw the samples upon which he makes an analysis, the solution to the difficulty while apparently simple, is not easily attained. The indifference of the public in general to follow written instructions places the analyst in the position of not knowing whether or not the material submitted to him for analysis is representative of the bulk lot of seed from which it was taken. It would seed that some united effort is necessary before we can reduce the risk arising from improperly prepared samples used in analysis.

There is another phase of the work of the analyst in which all crop improvement workers and vendors of seed are greatly interested; namely, "Germination standards and the dependability of laboratory conducted germination tests". The dependability of the germination test is a matter of serious concern to the vendor of seed because when a planted field fails to produce a crop, the first supposition of the purchaser is that the seed was responsible. Because it is more or less freely admitted that considerable variation exists as between germination in the laboratory and under field conditions, the purchaser is encouraged to hold to the claim that the vendor is responsible for the resulting losses.

When the vendor happens to be the member of a crop improvement association,

good will toward the association is impaired unless prompt action is taken to make adjustments satisfactory to the purchaser. In the mind of the farmer, there is only one conclusive germination test; namely, the results he obtains in the field; therefore, it may be concluded that just so long as there is any question concerning the dependability of laboratory germination tests, he will continue to hold the vendor of the seed responsible, irrespective of the true cause of failure.

We now come to the question of seed-borne diseases. The problem of dealing adequately with the control of seed-borne diseases is just around the corner, and in a very short time the analyst and the inspector of field crops and seeds will have to deal with this new problem. In attempting a solution to this rather vexing problem of seed-borne dieseases, the plant pathologist, the seed analyst and the inspector must all take on new responsibilities, and in some instances an entirely new viewpoint. In delegating a portion of the responsibilities to each group, coordination of service will be the keynote of success. I am extremely intolerant of the viewpoint that upon the service of any one group hinges the whole order of success. This view is the most destructive of all the agents responsible for undermining public confidence in crop improvement work.

I think in all this work we should emphasize the use of good seed as being the important thing rather than the production. It is only necessary to create the demand and production will, within certain limits, take care of itself. Thus our plans and legislation should be directed toward attainment of our main objective.

In all this I have not tried to provide the answers. The problem is too large for the opinion of any one person to be positive. However, in closing I would like to leave with you two thoughts.

You, as seed analysts, are part and parcel of the crop improvement programme. For this reason you are interested in the whole set-up of all its contributing forces, not with the idea of absorbing the troubles of the whole crop improvement programme unto yourselves, but with the thought that you look beyond the scope of your own activities to see how the work which others are doing affects your service.

Crop improvement is bigger than the production and use of pure, clean seed. Pure, clean seed production is only one cog in a very large wheel. Furthermore, seed legislation while admittedly helpful, is in turn but one small cog in the very large wheel of weed control. A gear wheel is only as strong as its weakest tooth, therefore our seed legislation can only be as effective as the weakest piece of complimentary research or legislation.

SEED TESTING IN ALABAMA

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Seed control work was instituted in Alabama because of a necessity. The condition and quality of seed being offered for sale in this state,as well as in neighboring states, became so bad that it was with a great deal of apprehension that a farmer paid his money to a dealer for planting-seed. Seeds were not only sold with a low germination and high weed seed and noxious weed seed content, but, probably worst of all, were sold with a misbranded variety name.

In recent years, seed testing in the laboratory has resulted in a marked improvement of the condition and quality of the seed. Very seldom will seed be offered for sale with a low germination or high weed seed and noxious weed seed content.

Because of the misrepresenting of the variety of seed, work was instituted that aimed toward eliminating seed misrepresented as to the variety. The result, in this case, has shown a very marked improvement in the types of seed which have been tested as to their variety. As you know, varieties of some seeds can not be told except by planting. Seeds of this type, therefore, have been planted on the test control plot of the Seed Laboratory on its station at Kilby Prison.

The most marked improvement that has been shown with any one variety has been with soy beans. Formerly, varieties unadapted to the southern conditions were represented as southern grown soy beans. This resulted in producing plants which were not capable of producing the growth that would produce normal crops under the climatic conditions encountered in this state. As a result, certain types of soy beans produced dwarfed plants which, in many instances, did not attain more than six inches of height, while the standard variety of soy beans would produce normal plants reaching waist to shoulder high. You may well see the losses that would occur in an instance like this.

A farmer must have the proper type and variety of seed for planting if he is to make a success of his work. Seed which is misbranded as to variety really does more harm to the farmer than does seed which is dead and will not germinate.

This is so because it is possible to replant seed which would not germinate, while the deception encountered from seed which germinates and produces a misbranded variety can not be told early enough for the farmer to replant and thus gain the use of the land for that year.

Abruzzi rye is better adapted to conditions in the South than is Rosen or many other varieties of rye. Rosen rye will hardly ever head in Alabama. Abruzzi rye produces an abundance of green material and may be used for winter pasturage, its rapid growth giving it the advantage over other types, particularly Rosen. In the past, there has been a very high percentage of substitution of Rosen and other varieties of rye for Abruzzi. In recent years, however, testing of the varieties of rye sold as Abruzzi has resulted in a decrease in the percentage of misbranding of the variety type.

The Alabama Law requires that the variety and common name be given for all seed sold in the State of Alabama. We do not believe, therefore, that seeds, the varieties of which are unknown, should be sold and, therefore, prohibit the sale of any seed bearing only a common name or bearing a name which, apparently, has been made up for the purpose of evading the provisions of the Law.

SEED CONTROL IN TENNESSEE

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The first seed control law, or attempt to control the sale of seeds, in Tennessee, was enacted in 1901. At that time the statute was apparently considered quite adequate. It dealt especially with Johnson grass, and, according to the provisions of the law it was illegal to bring into or to give away in Tennessee, any part of that plant. At the time of the passage of the law no means of or for enforcement were provided.

In 1925, this first law, because of its shortcomings was revised and amended into its present form. It is the opinion of the writer that it is entirely inadequate since there are imperfections in the law which make it practically impossible of enforcement. At the time of the enactment of the law its enforcement was placed in the hands of the State Chemist. This arrangement evidently did not prove very satisfactory since in 1926 the seedsmen went before the Governor of the State and requested an expert seed analyst. On July 1st, 1927, Mr. V. A. Berridge was appointed to take charge of the work. Several inspectors were assigned to him and he was given a room in which he was to organize a seed testing laboratory. Mr. Berridge carried on the work until October 1st., 1928, when the writer was appointed to take charge. At that time the laboratory and equipment were entirely inadequate and requests were made for assistance in several ways.

Tennessee was greatly in need of strict seed regulations at that time and the writer was determined to make the best of the situation. Efforts were rewarded during the first two years of enforcement. When previously about 1,300 samples were analyzed, the first two years of enforcement showed a total of slightly over 3,000 samples had been received. The recent report covering a two year period shows 8,100 samples tested. This has been done in spite of serious handicaps.

Farmers of Tennessee have previously done much of their seed business in Tennessee, however at the present time out-of-state markets are opening for Tennessee grown seeds and to meet that need adequate assistance, equipment and facilities must be made available if the laboratory is to function in a thoroughly dependable manner. The administrative heads of the Department have always realized the need of expansion but seemingly have been unable to secure the needed assistance. The writer is indeed grateful for this opportunity to attend the meetings of this Association for the first time, indeed the first time our State has been represented, and sincerely hopes that Tennessee will in the near future have a seed testing laboratory and control facilities adequate to meet our ever expanding needs.

SEED PRICE VERSUS SEED QUALITY

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For the past 30 years members of the Association of Official Seed Analysts and others in touch with conditions in the seed trade have attacked this major problem of American agriculture. It is noteworthy that during the life of this 30-year old organization progress has been made in the science of seed testing and that seed-trade conditions are improved over what they were three decades ago. Seed price versus seed quality, however, is still one of America's major agricultural problems. With no thought that this paper will present its solution but with the hope that it may be even a small contribution to the efforts being made to find an answer, the results of a recent survey on the subject are herein submitted.

But first, in order to get a clear perspective of the problem, we quote the Director of the Utah Agricultural Extension Service, who defines the problem and gives a concept of what is meant by "quality seed" when he says: "A farmer in Utah bought 'hot' alfalfa seed in the dirt at a cost of 10 cents per pound, when high grade, adapted, clean seed would have cost him 24 cents per pound. The seed had good germination and he got a good stand of alfalfa on a 10-acre patch. He saved 14 cents per pound on about 5 pounds of seed per acre. When his alfalfa began to grow he noticed that he had a fine sprinkling of Russian knapweed over the entire field. This had not been recognized until the knapweed had a good hold on the land. Moreover, the seed adaptable only to a warm climate, although well cleaned, beautiful in appearance, and having a high germination, produced a crop of plants that winter-killed 50 to 75%. It is estimated today that this farmer would have to spend at least $60.00 per acre to clean up the knapweed. In other words, he saved 70 cents an acre on seed and in doing this put a mortgage of $60.00 an acre on his land. This is about what happens when people try to save on seed, not to mention the loss sustained on the crop."

President Goss, in 1935, gave another view of the problem when he said: "It seems to me our greatest difficulty lies in the fact that we are trying to be our brothers' keeper and that most of our brothers have no interest in being kept. The price of seeds still appears to be the controlling factor in their purchase. Good farmers who notice other details of their business do the same thing when purchasing seeds, thus protecting themselves. Poor farmers who are careless in other matters purchase seed in the same way. Their faith seems unbounded."

Secretary Wallace in welcoming the Association's meeting in Washington City last year said, in part: "I suppose not one person in a thousand appreciates as completely as he or she should the importance of the difference between good seeds and bad seeds. You, of course, appreciate that, but you haven't driven home the appreciation of the difference in the public mind to the extent that you should. The seed trade as a whole has not driven home the difference to the extent that it should."

A glimpse at the other side of the picture, however, gives us hope that we shall not always remain indifferent toward this problem. Mr. Edgar Brown of the Division of Seed Investigations said in 1920 in his presidential address: "On the whole, conditions are greatly improved over what they were 10 or 20 years

ago." F. W. Taylor, president in 1923, gave this optimistic report: "Although the Association of Official Seed Analysts of North America is still in its adolescent period, it has already exercised a profound influence upon both national and state legislation, upon the quality of our farm seeds, and upon the resulting kind and quantity of field seed production." When it is considered that no longer ago than 1908 the United States imported some farm seeds that contained as much as 50% extraneous matter, the most of which was weed seed, and that farmers of the country had no defense against unscrupulous members of the seed trade, it is obvious that there has been noticeable improvement in conditions and that after all we may not have been as inactive and indifferent as we have seemed to be. From 1908 to 1938 is but a brief span in our national life, yet during this period a Federal Seed Act has been in force for many years, and we are ready for a new one more in keeping with the progress made in seed-testing research and new methods of processsing and marketing field seed. Very few of the states had seed laws in 1908, but in 1938 there are forty-six state seed laws whose general purpose is improvement in conditions affecting the distribution of farm-seed supplies.

This brings us to the question, "How effective have been these regulations upon farm practice? Are the states' laws enforced and if so, what are the conditions? If not, why not, and what are the conditions? Are we, in the words of Mr. Goss, trying to be our brothers' keeper without the brothers having any interest in being kept? Do farmers welcome the protection that seed laws are supposed to give them and do they demonstrate in actual practice, whether in buying seeds or growing them for the trade, they have grasped the full significance of quality in farm seed?"

Official seed analysts, seed-law enforcement officials, and directors of agricultural extension service in 43 of the 48 states answered these and other questions in a recent survey, made with the idea of ascertaining whether farmers are "price-conscious" or "quality conscious" in the purchase of seed supplies. If, as had been suspected, farmers as a rule look at the price tag before they do the analysis tag, the enforcement of seed laws is but to thrust upon them the benefits of enforcing such laws and the conclusion must be that farmers must go a long way yet before they fully appreciate the importance of quality in farm seed. To the question, "To what extent do farmers in your state buy their planting seed on a cost-basis rather than a quality basis?", the answers came back, as follows: One state said below 10%; one state answered from 10 to 20%; five states said 20 to 30% buy on cost; seven states have 30 to 40% who are cost-farmers; three states say the number is somewhere between 40 and 50%; in seven other states, the percentage is between 50 and 60%; five states have from 60 to 70% of farmers who are cost-minded; while in six states the number runs as high as 70 to 80%. Replies from eight states did not make a round-number estimate. The weighted average of the replies from 35 states that giva definite estimates is 43 to 53%. In other words, approximately 50% of American farmers buy field seeds with cost as the first consideration, according to these replies, and the other 50% consider seed quality as of primary importance. Supplementing these data, however, are those submitted by representatives of the seed trade and others in touch with seed-trade conditions. These data show an estimate of from 10 to 25% higher than the average given above. To give weight to these estimates, it appears that somewhere between 50 and 75% of American farmers considere cost before quality in the purchase of seed supplies.

The names of states in groups of percentage ranges follow:

Below 10%: Wisconsin
10 to 20%: Pennsylvania
20 to 30%: Ill., Me., N.Y., Oreg., R. I.
30 to 40%: Calif., Ind., Iowa, Mich., Miss., N.J., Okla.
40 to 50%: Conn., Mass.
50 to 60%: Ark., Colo., Fla., Ky., Neb., Texas, Wyo.
60 to 70%: Kan., Minn., Ohio, N. M., N. H.
70 to 80%: Mo., Mont., N. D., S. D., Tenn., Va., W. Va.

Question 2 was: "How much importance is given to the question in your state of educating farmers that 'cheap seed' is in the long run actually high-priced seed?" It was requested that this be answered by statement of what is being done. Replies from 43 states group themselves under the following headings:

1. All means of communication, including news releases, radio, bulletins, personal letters, charts, posters, mountings, and meetings of all kinds: Twenty-one states use some of these means, though probably no state uses the entire list.
2. A great deal of attention given the subject by extension service and others, 14 states.
3. Giving question no real emphasis - two states.
4. Teach value of good seed adapted to conditions - two states.
5. No direct correlation between price and quality - two states.
6. No definite program to encourage purchase of quality seed - one state.
7. No answer, one state.

States belonging to the various groups:

1. Ariz., Ark., Calif., Colo., Ill., Ind., Ky., Mass., Minn., Neb., N. H., N. J., N. M., N. Y., Okla., Oreg., S. D., Texas, Utah, W. Va., Wis.
2. Ala., Fla., Idaho, Iowa, Kan., Mich., Miss., Mo., N. C., N. D., Ohio, Va., Wash., Wyo.
3. Me., Mont.
4. Pa., R. I.
5. S. C., Tenn.
6. Conn.
7. La.

Question 3 was: "In order that a condition might be reached under which farmers as a rule would buy the higher grades of seed, which of two plans would be preferable for attaining this end; namely, (1) Education through the Extension Service, or (2) Enforcement of seed laws and regulations that would prohibit the sale of the lower grades of seed?" There were five kinds of replies to this question, grouped in the following manner:

1. Education and enforcement together, one as important as the other - 19 states.
2. Both, but education first - 10 states.
3. Education - 11 states.
4. Law-enforcement - 2 states.
5. No answer - one state.

States in the various groups are:

1. Ark., Conn., Fla., Ill., Mo., Minn., Neb., N.J., N.D., N.C., Ohio, Ore. R.I., S.D., Tenn., W.Va., Wis., Wyo.
2. Ala. Iowa, Kan. Mass., Miss., N.H., N.Y., Penn., S.C., Wash.
3. Ariz., Calif., Colo., Idaho, Ind., Mich., Mont., N.M., Texas, Utah, Va.

4. Me., Okla.

5. La.

Time does not permit compilation of replies to three additional questions included in this survey. Only by incident in connection with later discussion can we mention two of these, namely; first, the significance of the AAA program and, second, the estimated loss in states caused by weeds. The third of this series has to do with setting up standards for field seeds and the material on hand in this connection can be used for a report in the News Letter or for a discussion in a future meeting of the Association.

We wish to point to an example of correlation between the percentage of farmers who buy seed on quality and farmers who have had the advantages of cooperative programs in education and seed-law enforcement. In the state of Wisconsin, it will be noted, less than 10% of the farmers buy seed on a cost basis. What is the explanation? The answer, which should ring in the ears of the indifferent and lethargic and which comes from both the Director of Agricultural Extension and the Director of Weed and Seed Control, is simply this: "Education and law-enforcement are of equal value in Wisconsin and for years this question of quality in farm seeds has received primary attention both from the agricultural extension forces and the seed-law enforcement officials". Wisconsin might well say to some of her sister states, "If you would have your farmers as a rule fully appreciative of the importance of using good seed, 'Go, thou, and do likewise'." In a similar way, it is pointed out that, in those states where the larger percentage of farmers have received little instruction as to the importance of seed quality, the large number of farmers in those states who consider seed cost before seed quality bears evidence that there is close relationship between education and enforcement on the one hand and the use of good seed on the other. These are extreme examples, to be sure, but they emphasize the fact that there must be concerted and cooperative effort among leading agricultural agencies if we would have improvement in the quality of our seed supplies.

The significance of the AAA Program, one of whose provisions is the diversion of row-crop acres to pasture and soil-binding crops, and the loss to states caused by weeds are referred to in connection with the national financial loss caused by noxious and perennial weeds. Many of the states, especially those in the small-grain and seed-producing areas, report tremendous losses from noxious weed infestations. Agricultural leaders of those states recognize their weed problem as one that, without concerted action, almost defies solution. "A suggested National Program For Weed Control", outlined by a committee representing a North-Central States Regional Meeting in 1935, devised a plan for arresting the spread of the noxious weed pest. Information contained in this program is directly related to the question of quality in farm seed and to the AAA provisions, and it is of such a nature that it should have commanded the attention of agricultural leaders everywhere. Particular attention is directed to three statements in this report: First, "The annual tax levied by weeds on agriculture and industry in the United States is approximately three billion dollars"; second, "In amount of damage done, weeds cause losses that rank a close second to those caused by soil erosion"; third, "The Federal Government in cooperation with states has developed national programs that include insect, plant-disease, animal-disease, and soil-erosion control". Dr. O. S. Aamodt, of Wisconsin, when recently discussing these losses said: "This three-billion dollar loss, caused by weeds, is as much as that caused by insects and plant diseases combined, if not more." "Still", he said, "we have in practically every university and experiment station and Federal De-

partment of Agriculture large departments of entomology and plant disease dealing with insects and diseases and scarcely a project on the books of some experiment stations for investigations on weed control." He said that it appears as though the experimental institutions can be accused of being indifferent and for having failed fully to appreciate the importance of the weed problem.

The cheap-seed problem and the noxious weed problem are Siamese twins, in so far as injury to crop production is concerned. If we had always controlled the one we should have never been much troubled with the other. But this frightful monster has been permitted to range at will among rich farm fields and is taking a tremendous toll from the agricultural industry. It behooves all people concerned to bestir and awaken to the serious nature of the situation. The noxious weed menace cannot be divorced from noxious weed seed, and the damaging effects of both combined call for vigorous action on the part of all agencies interested in an improved national agriculture. The Association of Official Seed Analysts assumes its part of the responsibility for cleaning up the nation's premises of this weed menace, but it does not agree to the statement that it is our prerogative alone to "drive home" an appreciation in the public mind of the difference between good seeds and bad seeds. It is not alone the business of the Federal Department of Agriculture nor of any other agriculture agency acting independently to put the fields in order. The weed-seed problem and the noxious-weed problem are nation-wide problems, and every agency that exists on the continent,in the states,in the nation, and in the Canadian Provinces must lend a hand in the fight for good seed and be willing to give a full measure of cooperation. Research workers, extension people, law enforcement officials, the seed trade, official seed analysts, financial strategists, and all other agencies, all working together, will do for America what has been done in Europe; namely, put seed control in the front rank with other primary factors of efficient crop production and minimize, if not eradicate, the staggering losses caused by noxious weeds.

To sum up the situation: A considerable majority of farmers permits the factor of cost to take precedence over the more important factor of quality in the purchase of farm seed, and these farmers are inviting more injury to the three-billion dollar damage already done to America's most important industry. The agricultural extension service, farm organizations, seed-law enforcement officials, and other agencies have rendered yeoman service in urging upon farmers the importance of using good seed. But this survey, if it shows anything worthy of consideration, reflects that a clear majority, at least, of American farmers must yet be reached with the "Gospel of Good Seed" before we can have an efficient agricultural industry. The agricultural extension service, law enforcement officials, seed trade associations, national farm organizations, crop and seed improvement associations, official seed analysts, AAA supervisors, and all other groups interested in good seed must enlist in a cooperative, coordinated, definite plan for educating farm people that cheap seed is bought at a dear price.

These organizations, working hand in hand, in harmonious cooperation will reach American farmers with definite, convincing information that the continued use of marginal and sub-marginal seed is but to court ultimate losses to the agricultural industry similar in effect to the disastrous results of the exploitation of the nation's soil resources. The Association of Official Seed Analysts should assume a progressive leadership in a movement that would bring all agencies together and focus the attention of all people upon the importance of solving the nation's cheap-seed-weed-problem.

SOME PROBLEMS IN SEED MARKETING (ABSTRACT)[1]

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The field of seed marketing covers a wide range of activities and is the business of a number of agencies between production and consumption. Unless one has been intimately associated with the handling and marketing of seeds, it would be difficult for him to realize the large amount of work expended on them from the time they leave the producer till they are placed on sale for the consumer.

Cleaning--Much improvement has taken place in the process of cleaning seed since the use of the old-type of farm fanning mill. These improvements have been made primarily by people engaged in the seed cleaning business or by the manufacturers of such equipment. Public agencies, however, are concerned with the limitations in seed cleaning, particularly in the removal of noxious weed seeds, as this knowledge is necessary in the establishment of better methods of appraisal of the value of country-run seeds containing various kinds of weed seeds.

Bulking and Blending--The objects of bulking and blending seeds are twofold: First, to combine small lots of seeds from many growers into a few large lots of different grades, and second, to blend portions of these large lots to make certain commercial brands. From the standpoint of the Seed Verification Service, we are concerned with the guarding against the blending of seeds of different origins which have different adaptations.

Mention need hardly be made to seed analysts of the importance of thorough blending of all the seeds in any single lot prepared for sale. This is one of the most neglected processes in the preparation of seed for market. Improper blending is probably the cause of more controversies relative to the quality of particular lots of seed than any other single factor.

The value of lot numbers on seeds has been demonstrated time and again in connection with seed enforcement work. If a number of samples of seed from the same concern bearing the same lot number are picked up in scattered places, it makes a far stronger case in the determination of the factor of value than if each lot of seed sampled had to be handled as an independent unit.

Sampling--Probably seed analysts have given more attention to sampling and the representative character of samples than most other groups. It is a well known saying that "A determination made by an analysis of a sample can be no better than the representative character of the sample used." Proper blending is a necessary preliminary to accurate sampling and accurate testing. In sampling ununiform lots of uncleaned seeds as they come from the farm or improperly blended lots, the degree of accuracy is much lower than with clean, well blended seed, so that seedsmen find it necessary to make allowances for rather wide variations in tests of such seeds, even when special care is taken in sampling.

Dockage--It is a common practice to allow 2% dockage when buying forage crop seeds as they come from the threshing machine or after having been run through a simple type of fanning mill. Progressive seed dealers are recognizing the inequitable features of this system and are beginning to think of purchasing

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[1] For full text of this paper see Seed World.44.2:13,19,and 2:13,1938.

this class of seeds on the dockage-free basis. In line with this idea, the Hay, Feed, and Seed Division of the Bureau of Agricultural Economics was requested by a number of seedsmen a few years ago to draw up rules for the application of dockage to timothy seeds. The Farm Seed Group of the American Seed Trade Association, at its meeting in Detroit this week, took favorable action on this matter and requested the Bureau of Agricultural Economics to establish a dockage inspection service on timothy seed to be effective on this season's crops. It is thought that this will be extended to include other grass and clover seeds.

Seed Standards--Standards for seeds have been discussed by Federal and State agencies for the past 20 years. Although no special investigational work has been done along this line, the viewpoint of the state agencies in recent years appears mostly to be opposed to such standards. There are arguments for and against the establishment of standards for seeds. In Canada, where there are numerical seed grades, there are proponents for and against such standards. There has been a decided opposition to seed standards by most of the seed trade in the United States, and the writer has felt that the analysts, in general, have been opposed to such standards, although perhaps you have not formally expressed yourselves in this matter. In the U. S. Department of Agriculture, there is no preconceived opinion for or against seed standards, and if there is to be any investigational work along this line, it will be done with an open mind on the subject.

Seed Records--In the evaluation of seed for planting, there are two groups of factors to be considered. The first of these, such as viability, purity, size, and color, can readily be determined by a laboratory analysis; while the second, which has to do with such factors as place where grown, year in which grown, variety, and strain, requires an accurate history or pedigree of the seed. In 1927, following two annual conferences between agencies of the State and Federal governments and commercial organizations, the Seed Verification Service was inaugurated by the Bureau of Agricultural Economics. This service was for the purpose of providing information as to origin of commercial alfalfa and red clover seed. During the past 11 years, this service has demonstrated the efficiency of an organized system in furnishing information as the afore mentioned properties of seeds which cannot be determined by a laboratory analysis.

Until we adopt some system of records for the seeds that are handled by seedsmen, we will have no method of checking the really vital factors of quality in seeds. In the most recent draft of the Federal Seed Bill (H.R. 10816), there is a section devoted to "records". If this becomes a law, it will give authority to apply records as a basis of control for origin and certain other things.

Seed Certification--Varietal certification of field seeds has been done almost entirely by state Crop Improvement Associations in cooperation with state Agricultural Colleges and Experiment Stations. National cooperation among these groups has been brought about through the International Crop Improvement Association and the Extension Service of the U. S. Department of Agriculture.

It is apparent that some research work on seed certification should be done in order to bring about greater uniformity in methods of certification and marketing of improved seed and to stimulate greater utilization of such seed. Among the points which should be included in such an investigation are:

1. Varieties approved for certification.
2. Approved sources of foundation seed.
3. Maintenance of supplies of registered foundation stock seed.

4. Methods and costs of field inspection.
5. Types of records to be kept by producers of foundation seed and of certified seed relative to source, production, harvesting, threshing, and cleaning.
6. Forms of certificates used and records kept of certification.
7. Methods of merchandizing certified and improved seed.
8. Uses of nomenclature, terminology, and standards of description in merchandizing certified seed.
9. Types of records needed by the several types of seed handlers.

PROGRESS IN THE SEED INDUSTRY (ABSTRACT)[1]

Earl M. Page
Representative of American Seed Trade Association

Through the centuries men have gradually learned that yields can be increased by the saving of seeds from the most productive plants. "Like begets like" was an old adage, but it remained for Mendel, early in the 19th century, to decipher this and give to the world the modern concepts of heredity by which it is possible to produce thousands of new varieties in many types of plants.

Nowhere in the world is the improvement in varieties and strains carried on so intensively or on such a vast scale as in the United States and Canada. Federal, State, Dominion, and Provincial experiment stations and the seed companies with their breeding and testing farms have all contributed, but it remains largely for the seedsmen to make these improved seeds available to the public. As a result of this, a wider variety of seeds of truer, purer stocks of farm crops, vegetables, and flowers is offered to the North American public, at comparatively lower prices, than in any of the other countries on earth.

It was my privilege last year to visit a number of seed growing districts in several European countries where I saw some well equipped seed cleaning plants, but I can safely say that the use of modern seed cleaning machinery is far more general in North American with resulting higher purity and greater freedom from weeds in the seeds which are offered by North American seedsmen. Probably similar comparisons could have been made several years ago before the general existance of seed laws, but never-the-less the members of the American Seed Trade Association give full credit to Federal and State seed laws, to their enforcement agencies, and to seed analysts generally for excelerating the rate of progress in improving seed quality, particularly with respect to purity and freedom from weeds.

PRESENT DIFFICULTIES

Relying on adequate seed law enforcement, the seed industry has invested large sums of money in order to serve an ever increasing population with better and better seeds. Several factors have, however, operated against the legitimate seedsman to prevent him from consistently collecting a reasonable premium for better quality seeds.

Chief among the factors affecting field seed prices is the fact that, on many varieties at least, 75% of the seed sold does not move through the seed trade, but moves in an uncleaned condition from farmer to farmer or by irresponsible truck peddlers with no effort to comply with seed laws or to prevent the spread of weed seeds. These uncleaned and unregulated seeds establish the price in the minds of the consumer so effectively that it has been impossible to sell at a price sufficient to cover the cost of cleaning, testing, and handling any field seed that is available from farmer to farmer or truck peddler to farmer. This has left the field seedsman, with his cleaning plants, with only the fringes of the real market dependent for his existence on being able to supply seeds when not available locally, either by reason of local shortage or remoteness from producing areas.

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[1] For full text of this paper see Seed World. 44. 4:7, 13, 24.1938

To correct this situation, it will require, in addition to adequate seed laws and vigorous seed law enforcement, a program of education. I believe that, with but few exceptions, state seed laws exempt farmers from provisions of the seed law in selling seeds which they have produced regardless of the weed content, purity, germination, or any other matter. Illinois is a remarkable exception to this and has done a remarkable work.

There is evidence that the country is becoming more and more weed conscious. Some states have undertaken vigorous campaigns for the eradication of certain weeds. The time is right for action and the seed trade is willing to assume its share in the responsibility of cleaning, testing, and properly labeling seeds distributed by it. I am sure that the seed trade would also cooperate in any educational program undertaken by the Department of Agriculture or by the states or provinces.

Your group, the Official Seed Analysts of North America, recognized as a scientific body and closely affiliated with seed law enforcement, is in a particularly favorable position to lay the foundation for such an educational program by pointing out to the states, perhaps in the form of an official resolution, the inconsistency of exempting farmer-to-farmer sale of seeds from the provisions of seed laws, particularly when it is estimated that 75% of all the farm seeds planted are sold to the consumer without recleaning, testing, or labeling.

The New Federal Seed Law, now under consideration, is another forward step in the progress of the seed industry. The American Seed Trade Association has cooperated in every way possible in the development of this law which should be equitable, effective, and comprehensive. It is hoped that this law will place the interstate shipment of seeds on a higher plane, giving protection to the consumer and protection to the investment of the legitimate seedsman.

It has been a pleasure for me to be with you again, and, in closing, let me extend to you the continued best wishes of the American Seed Trade Association.

SEED LABORATORY RECORD CARD DATA

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By a tacit understanding between the University of California Agricultural Experiment Station and the California State Department of Agriculture, problems of an educational and research nature are primarily for consideration by the University, whereas regulatory and certain service functions are involved in the work of the State Department of Agriculture.

This delegation of responsibility is reflected in the work carried on by the State Seed Laboratory. The California Seed Law requires that agricultural seed be labeled, and further requires that the Director of Agriculture establish a seed laboratory for the dual purpose of enforcing the labeling provisions of the law and testing samples of seed submitted by citizens of California under such rules as he may adopt. California's Agricultural Code makes the dissemination of pests unlawful and defines weeds and weed seeds as pests.

Fifty of California's 58 counties have county agricultural commissioners who are designated as co-enforcing agents of the "Agricultural Seeds" (Seed Law) provisions of the Agricultural Code. In this capacity they make inspections to determine whether or not seed labeling requirements of the Code have been met and, if labeled, whether the proper information is provided. They are, as plant quarantine and pest control officers, expected to protect their counties from pests, particularly those which threaten agricultural crops. Therefore, the county commissioner may invoke his quarantine powers and reject such planting seed as may be determined to contain seeds of noxious weeds. This action is taken upon destination inspection by the commissioners, which means that all lots of seed arriving in any county are subject to inspection for noxious weed seeds. In most counties, this inspection consists of drawing a sample from the shipment, sending it to the State Seed Laboratory for weed seed examination, and holding the shipment pending report from the State Seed Laboratory.

California has a year-round planting season with the result that laboratory receipts are a fairly uniform flow; hence these two lines of enforcement and the service tests, made largely as an aid for law observance by supplying information to individuals or dealers as a basis of label statements, leave little time or equipment available for investigation.

There are, however, in the files of the Seed Laboratory, record cards showing the results of laboratory tests made since the laboratory was established. An analytical utilization of this statistical information reveals data comparable in a sense, at least, to that developed by certain forms of industrial research pertaining to the utilization of by-products now going to waste.

Accordingly, when in 1935 we were asked to outline a WPA project in which the labor involved would be supplied without expense from our appropriation, we presented the project of assembling the data from our record cards. The project was accepted on the basis of the Seed Laboratory furnishing office space, supplies, and necessary supervision. As a result, some of these available data have been summarized. Since the completion of the WPA project, we are not only continuing the work, but are including all samples submitted to the Laboratory.

Thus far, the work has been confined to the determination of average puri-

ties and germinations, together with the number of samples tested and the percentages of the total found falling in arbitrary ranges. The occurrence of seeds of noxious weeds has also been tabulated for each weed named in the California Seed Law to show the extent of occurrence. The rate on number per pound, is not shown.

To date, the chief use made of this material is in answering inquiries relative to general quality of some particular kind of seed. We recognize the fact that the value of these data are limited by the number of samples tested in any one year, but the results from year to year, when compared, afford some definite basis for an estimate of quality. The data assembled go back to 1929 and include all the kinds of seed received in appreciable numbers. Beginning in 1936, all samples are being included in recognition of the fact that the number of samples received indicates their importance or lack of importance in California. These data pertaining to kinds represented by a relatively large number of samples are being studied to determine how they can be presented in condensed form to show the general quality of the crop and its record for uniformity. It is our belief that a summary of these records will be of value to seedsmen, analysts, and seed growers, as well as to enforcing officers.

THE SEED SAMPLE AND ITS LIMITATIONS (ABSTRACT)

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The seed sample has very definite properties and limitations and to ignore these and be careless with it violates the first fundamental principle of seed control. Responsibility begins the moment one first thinks about securing a sample and from that time until the sample is closed or sealed the practices or procedure followed are bound to limit the faithfulness and usefullness of the sample. The risk involved in an improperly secured sample is very great. A seed sample has very definite limitations and these cannot be exceeded. This is particularly true when making a noxious weed seed rate determination, which like some other determinations is closely circumscribed by the size of sample.

Just at this time when there seems to be a tendency for a certain few individuals to go about relating how widely analyses and tests made by different laboratories vary, the writer would like to make a plea for better samples and sampling, since investigation into a number of these complaints frequently reveals that the sample and not the technician is at fault. Far too often the complainant is concerned only with the results the laboratory secured upon the sample and gives but little if any concern as to what sort of a sample the analyst had to work with. Finess in technique or method can be quickly and easily voided by an improper sample.

Most complaints allege that samples from the same lot of seed when sent to two different laboratories gave widely divergent results. Such samples may or may not faithfully represent the same lot of seed. The proper procedure in such cases is to have the two laboratories concerned exchange samples and retest in order to reveal the discrepancy, if such exists. If subsamples or second samples are submitted for retest they should always be tested along with retests of the original. Samples which are purported by senders to be duplicates can be checked in one or more ways, viz., by weight per 1000 seeds, by bushel weight, by comparative color under true daylight lamp, by their impurities, and by speed of germination. Some very puzzling complaints which at the outset seemed to be real, have been solved by use of one or more of the above useful controls. All parties concerned should be particularly interested and should cooperate to get at the exact facts since there is every evidence that manipulated samples have and may be used to reject shipments, to set aside rules and regulations or laws, and to evade just legal control.

In the opinion of the writer the comparing by seedsmen of test results from two or more laboratories with no certain proof of identity of the samples is open to the same serious criticism as the comparing by seed control officials of two or more seed stocks without authentic official samples. Likewise, the use of any but official samples for comparative tests is unethical. The circulation of reports of tests upon any submitted samples without the permission and consent of the laboratories involved or without adequate control of the samples is both unethical and unfair and is of real advantage to no one.

Investigations show rather conclusively that the use of but one of many sealed paper packets of commission-box vegetable seeds returned unsold at the end of the season is not safe for determining viability of the seed stock for prospective use the following season. This is also true of cartons of lawn seed-

ing mixtures. Only samples from well mixed bulks are safe for such purposes. Samples of certain kinds of seeds, such as the Brassicas, in thin paper envelopes when circulated thru the open mails are subject to serious injury by crushing. Several such have been received, even a referee sample arrived which had been subjected to such pressure in the mails that the seeds were plainly imprinted upon and even pushed thru the paper container. Such samples should not be accepted for testing but should be returned to the sender, or if tested, the results should be qualified by very definite statements regarding the condition of the sample when received. To accept such samples or any others which are plainly incompetent or deficient militates against confidence in good seed testing work.

Analysts everywhere are urged to challenge complaints registered and to do everything possible to solve discrepancies or unreasonable variations. One should not hesitate to reject or disqualify what appear to be non-representative samples. Often it is very wise to resample the original stock. Tradesmen should not permit the taking of official samples from market stocks except in the officially prescribed manner. In this work all concerned can be of great service to seed testing by paying far more attention to the sample and to keeping it inviolate at all times.

SOME OBSERVATIONS REGARDING NOXIOUS WEED SEED DETERMINATIONS[1]

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Since tolerances have been worked out and allowed for purity, weed seed content and germination determinations, there has come more and more a demand for a definite tolerance to be applied to noxious weed seed determinations. According to Collins[2] there are three important factors in such determinations: first, number of noxious weed seeds in the sample, second, the degree of certainty, and third, the tolerance. Tolerance for noxious weed seeds has been defined as the number of seeds to be allowed in excess of the stated number. To set up such a tolerance for noxious weed seeds is not as easy as for purity and germination determinations. The number of weed seeds must be expressed as a rate of occurrence per unit weight, generally per ounce or per pound. To determine this rate, an amount of the bulk sample sufficient to give a reasonable degree of certainty must be examined. In other words, the degree of certainty chosen must not be so high that the amount of bulk required to be examined is not feasible. As to a definite degree of certainty Leggatt[3], in his statistical work, has established a probability of .025 or 1 in 40 as giving a tolerance which corresponds very well with the tolerance worked out in practice and expressed by our present tolerances for purity and germination. Whether we use such a degree of certainty for noxious weed seed or a lesser one, such as 1 in 20, depends largely upon whether the amount to be examined in order to give the degree of certainty is feasible. These two factors cannot be considered separately, and in addition and also of great importance is the degree of accuracy which must be chosen so as to make certain that more inferior seed will not be passed in the trade than at present. All of this makes a very difficult problem.

The use of a tolerance for noxious weed seeds is not favored by some because of the risk apt to be taken by the vendor. Yet, in enforcement without such a tolerance but where a definite standard by law exists, many vendors take great risks anyway because they base their determination of noxious weed seeds upon the examination of too small an amount of the bulk, and furthermore, the bulk sample is often not carefully drawn so as to be truly representative of the lot to be labeled. The use of a tolerance for noxious weed seeds might lead to greater safety in one respect, at least, for the vendor; namely, that the amount of seed examined might not so often be the single sample of minimum weight now in such general use, which is rarely safe except in cases where large numbers of weed seeds are present. However, in the adoption of a tolerance this question of risk should be carefully considered.

In the case of small numbers (30 or less per unit weight) of noxious weed seeds present in rather large bulks and especially such small numbers as exist when a noxious weed seed does not occur frequently enough in a lot to recur in

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[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 284.

[2] Collins, G. N. The application of statistical methods to seed testing. U. S. Dept. Agri. Cir. 79: 1-17. 1929.

[3] Leggatt, C. W. Purity and germination tolerances fundamentally the same problem. Proc. Assn. Official Seed Analysts North America. 1935:101-107. 1935.

all samples drawn from it, a tolerance cannot be worked out by means of the standard deviation determination, as is used for numbers larger than 30. Since the variations in the case of small numbers follow the Poisson distribution, the variability to be expected for different low rates of occurrence can be determined from Pearson's table of the Poisson distribution or by rearrangement of the material in the table in a form to fit the problems of the seed analyst. Such an adaptation of the Pearson table of Poisson distribution is given in the revised Rules for Seed Testing.

Preceding this table in the Rules, a few concrete examples are given in explanation of the use of the table. Three uses that can be made of the table are given:

1. A guide to the amount of bulk that should be examined in any given case.
2. A guide to the variation to be expected in replicate tests.
3. A determination of a tolerance suitable to a particular case.

Let us apply these uses to an official sample of red clover seed which was found unlabeled on the market as to noxious weed seed content, although it should have been labeled, since it was found to have noxious weed seed content of 8 curled dock (Rumex crispus) seeds per ounce, or 120 per pound. The entire sample contained 110 grams. After establishing the exact rate of occurrence, a test of the degrees of certainty of 1 in 10 or 1 in 20 was made by 20 successive replicate examinations of 1 ounce each. (In this investigation 30 grams, approximately one ounce, were used. Therefore, where the term ounce appears in this paper it should be understood to mean 30 grams.) The results are shown in the following table:

TABLE 1

TEST OF THE DEGREE OF CERTAINTY OF 1 IN 20 BY 20 SUCCESSIVE EXAMINATIONS OF ONE OUNCE DRAWN FROM AN OFFICIAL SAMPLE OF RED CLOVER WEIGHING 110 GRAMS.

Actual rate of occurrence of dock, - 8 per ounce, or 120 per pound

Ounce examinations	Number of dock seeds found	Rate per pound	Theoretical maximum for each different rate with 1 in 20 certainty
1	5	75	150
2	7	105	-
3	7	105	-
4	12	180	-
5	13	195	300
6	12	180	285
7	12	180	-
8	11	165	270
9	9	135	225
10	9	135	-
11	14	210	315
12	10	150	240
13	10	150	-
14	9	135	-
15	6	90	165
16	7	105	195
17	10	150	-
18	9	135	-
19	8	120	210
20	10	150	-
Total	190	-	-

Average, 9.5 seeds per ounce, or 143 per pound.

The range is seen to be from 75 per pound to 210 per pound, or from 5 to 14 per ounce for the actual or known rate of 120 per pound, or 8 per ounce. When we refer to the theoretical range of expected values for different degrees of certainty as given in Table 2 of our Rules, we find that for 8 per ounce as many as 13 may be expected to occur once in 10 times and as many as 14 may be found once in 20 times and as many as 16 may be expected once in 100 times. Which of these degrees of certainty does the actual finding fit best? Referring again to Table 1 showing the tabulation of the 20 examinations, we find 13 seeds did occur actually only once in the first 10 one-ounce examinations and that 14 seeds occurred only once in the 20 one-ounce examinations. The actual findings then agreed closely with the theoretical in the two degrees of certainty tried out, but by expressing the maximum ranges for the different degrees of certainty in rates per pound and comparing these values with the actual rates found, we can learn which degree of certainty corresponded to the actual maximum found of 210 per pound. This is shown in the following tabular form:

Actual occurrence equals 120 per pound or 8 per ounce.

If 30 grams or 1/15 pound is examined, the expected number is eight. Referring to Table 2 of the revised rules, we find the maximum number of seeds allowed when eight is given:

For 1 in 10 degree of certainty is 13, or 195 per pound
For 1 in 20 degree of certainty is 14, or 210 per pound
For 1 in 100 degree of certainty is 16, or 240 per pound
For 1 in 1000 degree of certainty is 19, or 285 per pound

Thus we see that for ounce examinations, the actual maximum found of 210 per pound corresponds or agrees with the theoretical maximum for 1 in 20 degree of certainty and that this maximum then would be the upper tolerance limit for seed labeled 120 curled dock seeds per pound if a tolerance is allowed. Of course, 30 grams, or an ounce is less than the minimum amount given in the Rules for a noxious weed seed examination of red clover seed.

The question now arises as to the amount of seed or size of sample to be examined in arriving at the theoretical maximum limit or range of variation. Should it always be 30 grams, 50 grams, or some definite amount? In the official sample mentioned, it was necessary to examine 20 ounces, or 600 grams, in order to obtain the actual maximum occurrence for the two degrees of certainty. Of course this is not ordinarily feasible. A Poisson table, or an adaptation of it, shows how important the given or expected number of seeds or individuals is in determining this range of variation. Because of this, the amount to be examined should be chosen so as to fit an expected number of seeds, not too small. Then if it is desirable to examine a larger amount of the bulk, the chosen amount can be used as a unit weight and further examinations made. Of course, it would be desirable if the expected number for the different rates could always be the same, but this may not always be practicable. As the numbers become larger, distribution becomes more nearly normal. For this reason tables of Poisson distribution are not carried beyond 30. For larger numbers the square root of the number may be used as a close approximation to the standard deviation of the number.

In the 143 per pound rate established for the official sample of red clover by examination of 20 ounces, we obtained 10 different rates, varying from 5 per ounce to 14 inclusive or from 75 per pound to 210 per pound inclusive. Calculations of the theoretical maximum for each of these rates gave variations ranging from 150 to 315 inclusive for ounce examinations and for a degree of certainty

of 1 in 20, as shown in Table 1. The actual calculations for obtaining the maximum limits for two of these rates will show how the expected number of seeds governs the amount to be examined.

First calculation. Given rate of 150 per pound:
If we examine 30 grams, or 1/15 pound, the expected number in 30 grams will be 10, then entering the table with 10, we find 16 as the maximum allowed. Since 1 seed in 30 grams equals 15 per pound, 16 seeds in 30 grams equals 240 per pound, the maximum limit, which is not to be exceeded more than once in 20 times.

If we examine another ounce, 20 seeds would be expected with 29 allowed. One seed in 2 ounces, or 60 grams, equals 7.5 per pound, then 29 seeds in 2 ounces, or 60 grams, equals 218 per pound, the maximum allowed.

Second calculation. Given rate of 90 per pound:
(a) Examine 30 grams or 1/15 pound and expected number is six with 11 allowed. One seed in 30 grams equals 15 per pound, then 11 seeds in 30 grams equals 165 per pound, the maximum limit for a 30-gram examination.
(b) Examine 50 grams or 1/9 pound and the expected number is 10 with 16 allowed. One seed in 50 grams equals nine per pound, then 16 seeds in 50 grams equals 144 per pound, the maximum for 50-gram examination.
(c) Examine 100 grams. Expected number is 20 with 29 allowed. One seed in 100 grams equals 4.5 per pound, then 29 seeds in 100 grams equals 131 per pound, the theoretical maximum limit for 100-gram examination.

Hence, for the seed labeled "90 per pound" the calculated maximum rates per pound allowed for examination of 30 grams, 50 and 100 grams are 165, 144, and 131 respectively. It is now evident that on account of the expected numbers and their relations to the various labeling rates, it is not possible to use a definite amount of bulk for all examinations. This does not mean that the size of sample to be examined is any less important. The minimum quantities for bulk examinations given in the Rules for Seed Testing have been worked out in practice and differ for different sizes of seeds because approximately the same number of seeds for the analysis or working sample has been chosen for the different kinds and sizes of seeds. Hence, it is desirable to begin with examination of the minimum amount mentioned in the Rules for the kinds of seed analyzed whenever that minimum amount gives a desirable expected number of about 10 for the labeling rate.

The importance of the size of sample is readily seen in the results of the replicate 1-ounce examinations of the official red clover bulk sample of 110 grams. The labeling of this lot of red clover on the basis of either the 1st or 15th ounce examination or by the average of both results would have been incorrect, since the rates obtained, of 75 and 90 per pound, respectively, would not have been "in excess" under the Uniform State Seed Bill and would not have been shown on the label, whereas, any of the other 18 rates would have indicated that this stock of seed must be labeled as to its noxious weed seed content. Since the two low rates of five and six per ounce each occurred only once in the 20 examinations, the degree of certainty for each was only 1 in 10, which is unsafe in labeling on the basis of only 30-gram examinations. However, when the rate found is close to the borderline established by law or regulation as the six per ounce or 90 per pound rate, it is not to be expected that even a very large sample can give a degree of accuracy high enough to enable the vendor and the inspector to know that a violation does not exist.

Next let us consider the same Uniform State Seed Bill labeling clause, pre-

supposing a tolerance and applying it to the 90 per pound or six per ounce rate, obtained only once in the 20 trials. If we examine 50 grams or 1/9 pound which gives an expected number of 10 with 16 seeds allowed and find 14 seeds, there is no violation for a 1 in 20 certainty in the "90 per pound" labeling because 16 allowed equals 144 per pound. If we now examine a second bulk of 50 grams and find 15, it still is not a violation because in the 100 grams, 20 is now the expected number and entering the table with 20, we have 20 allowed and we have found 14 plus 15 or 29 seeds. With as close a result as this, a third bulk of 50 grams should be examined. If 12 seeds were found this time, the allowable number would be 40 for the expected number 30 and 14 plus 15 plus 12 equals 41. The respective maximum rates obtained in the three examinations are as follows:

For 50 grams, 9 x 16 or 144 per pound maximum
100 grams, 4.5 x 29 or 131 per pound maximum
150 grams, 3 x 40 or 120 per pound maximum

150 grams where 41 seeds were found, the maximum would be 123 per pound, and after the third examination, a violation would be established.

This question of tolerance should be considered in another aspect. If a vendor or the commercial analyst making the rate determination obtained the "90 per pound" rate for the lot from which this official sample of red clover was finally taken and which was found to contain dock seeds at the rate of 120 per pound, what would he have stated on the label? Would not the analyst have first worked out the tolerance limit from the table in the Rules and found it to be 144 per pound? Then, would he not have decided that it would be safe to release this seed on the market unlabeled as to its noxious weed content? On the other hand no tolerance allowed, he would have labeled it "91 per pound" or more, because he would have been aware of the possibility of variations in repeated determinations that these were not permitted in noxious weed seed determinations.

This whole question of tolerance brings forward some very practical considerations. In the first place in framing the Uniform State Seed Bill in which specific limits were established, was it expected that labeling would begin when the rate of occurrence of noxious weed seeds was "in excess of" the specified limits set, or on the other hand was it to be expected and is it now expected that a degree of latitude is to be allowed on those specified limits under the intended meaning of "in excess of"? What is the true meaning of "in excess of" as it appears in our laws? If no latitude or tolerance is to be allowed, then the vendor in order to be safe from prosecution and publicity must learn the safe limit back of which he must remain before labeling is to begin or to be seriously considered. Upon either premise we must all recognize and become very familiar with the application and significance of these maximum latitudes or expressions of tolerance limits. In any event and at the very outset, it is highly desirable that whatever policy is pursued, it must be uniform for all concerned.

A COMPARISON OF THE REGULAR METHOD AND A FRACTIONAL METHOD OF ANALYZING ORCHARD GRASS SEED FOR PURITY

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At the 1933 meeting, Miss Mary E. Woodbridge of Geneva, New York, described a fractional method adapted to the analysis of orchard grass seed.

Due to the apparent dependability and the time saved by the use of this method, Miss Woodbridge proposed its consideration and use.

In accordance with this proposal, the Virginia laboratory has analysed 50 samples, following in all important respects the Woodbridge method. We did not make replicate trials, but analysed individual samples once by each method. In making these analyses, the procedure was as follows:

1. The working sample of approximately two grams was prepared and the analysis completely made with the exception of removing the attached florets from the pure seed separation.

2. The customary four weighings were made.

3. The pure seed portion, including attached florets, was divided either on the board or in the Kny-Scheerer Mixer to within 0.0005 grams of one-fourth of the pure seed portion. The empty florets were removed from the one-fourth. The inert matter secured from this was weighed and multiplied by four. This was added to the weight of the inert matter, already separated, and substracted from the pure seed (including attached florets) weight. The entire percentage composition was then calculated, thus completing the analysis by the fractional method.

4. As a check, the three-fourths remaining pure seed was purified of its attached florets. Calculations on this complete analysis were made and the difference in percentage, if any, between the two methods was recorded.

The greatest difference observed was 1.37% and the tolerance in this case for the percentage found by the regular method was 4.26%.

The averages found for the 50 samples tested were for the purity by the regular method, 85.97% and by the fractional method, 85.87%; the difference being 0.36% on the average. The tolerance for the average purity by the regular method was 3.00%. The time involved in removing the attached florets on the full amount was 37.5 minutes and for the fractional method, 9.5 minutes.

Time saved and the apparent dependability of the fractional method lead us to propose further investigation. It is our suggestion, therefore, that the Research Committee send out referee samples of orchard grass this coming year with instructions that these be analysed by the regular and fractional methods.

Table 1 gives detailed findings of the investigation of the use of the Woodbridge proposed fractional method, as interpreted by this laboratory. There are differences in procedure, but we have attempted to follow the essentials of Miss Woodbridge's proposal.

TABLE 1

STUDY OF 50 ORCHARD GRASS ANALYSES MADE BY REGULAR AND FRACTIONAL METHODS

Sample No.	Purity % regular method	Purity % fractional method	Difference in purity % between methods	Purity tolerance, regular method	Time involved in removing double florets (Minutes)	
					Regular method	Fractional Method
1	93.60	92.95	.65	1.48	62	17
2	93.22	93.22	.00	1.56	40	10
3	92.64	93.34	.70	1.68	55	15
4	92.28	91.62	.66	1.74	40	10
5	91.82	91.22	.60	1.84	24	6
6	91.72	90.84	.88	1.86	65	15
7	91.40	91.00	.40	1.92	26	6
8	91.20	91.26	.06	1.96	23	5
9	90.50	90.90	.40	2.10	24	8
10	90.47	90.72	.25	2.10	34	8
11	89.22	89.58	.36	2.36	45	11
12	89.16	89.35	.19	2.36	33	8
13	89.14	89.37	.23	2.38	32	8
14	88.93	89.30	.37	2.42	55	15
15	88.66	88.53	.13	2.46	25	7
16	88.60	88.96	.36	2.48	35	10
17	88.56	88.29	.27	2.48	27	8
18	88.41	88.49	.08	2.52	37	10
19	87.87	87.70	.17	2.62	38	8
20	87.17	86.56	.61	2.76	40	10
21	87.07	86.79	.28	2.78	60	10
22	86.54	86.39	.15	2.90	33	8
23	86.26	86.95	.69	2.94	35	9
24	85.85	85.48	.37	3.04	20	5
25	85.71	85.92	.21	3.06	33	8
26	85.68	84.87	.81	3.06	50	10
27	85.57	85.19	.38	3.08	35	10
28	85.28	85.11	.17	3.14	40	10
29	85.17	85.63	.46	3.16	40	10
30	84.32	84.24	.08	3.34	36	8
31	84.21	84.11	.10	3.36	50	10
32	83.79	83.95	.16	3.44	40	10
33	83.77	83.39	.38	3.44	30	10
34	83.69	83.04	.65	3.46	28	8
35	83.57	84.00	.43	3.48	45	10
36	83.25	83.60	.35	3.56	40	10
37	83.12	83.54	.42	3.58	38	8
38	82.93	82.52	.41	3.62	36	10
39	82.92	81.96	.96	3.62	35	10
40	82.77	82.81	.04	3.64	34	8
41	82.70	82.68	.02	3.66	33	9
42	82.65	82.63	.02	3.68	42	12
43	81.92	81.93	.01	3.82	60	14
44	81.33	80.97	.36	3.94	20	5
45	81.05	81.21	.16	4.00	30	8
46	80.64	80.17	.47	4.08	46	12
47	79.72	78.35	1.37	4.26	23	8
48	78.44	78.56	.12	4.52	51	13
49	77.88	77.98	.10	4.62	30	10
50	76.05	76.33	.28	5.00	28	6
Average	85.97	85.87	.36	3.00	37.5	9.5

A NEW SEED BLOWER

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At the last annual meeting, the author presented a short note outlining the principles of a new seed blower. Since that time we have had the opportunity of doing more work on the subject with the result that a number of refinements have been introduced which have added very materially to its accuracy and efficiency. A new instrument embodying these changes has been built and is now on exhibition here.

It will be recalled that the new blower consisted of a box divided into two compartments with an opening in the partition through which air was forced mechanically; thus one side of the box became a low-pressure and the other a high pressure space. On the low pressure side, an air-gate was provided to control the amount of air-flow, while the air take-offs for the blower tube and for the manometer, were on the top of the high pressure side.

The same principles obtain in the present instrument although the arrangement is a little different, being more compact. The following changes increase greatly the delicacy of the blowing. A three-point support has been provided with levelling screws as in a balance. This is of great importance since the slope of the manometer has been reduced to 1 in 10, magnifying readings X10, and any change in the level of the blower is reflected in the manometer reading. For the purpose of assuring a true level, a centre bubble spirit-level has been added. Figures to illustrate performance will be presented later, but it may be mentioned that exceedingly minute increases of pressure will bring out a few more seeds. The slope of the manometer scale being 1 in 10, the millimeters on the scale represent tenths of a millimeter in actual pressure in terms of coal-oil with a specific gravity of approximately 0.8. It is possible, further, to estimate closely to 2/100 millimeters actual pressure if such close reading should be desired. It will readily be conceived how minute these pressure differences are.

Since the instrument is levelled before use, with a fixed manometer scale the manometer fluid would not always be at the zero mark when the motor is at rest, owing to fluctuations in temperature. An adjustable manometer scale is accordingly provided by which adjustment to zero level can be made by means of a thumb-screw.

All these precautions would be of little avail if one could not rely upon a constant pressure from minute to minute. This has been provided by the use of a constant speed, 1/75 H. P. motor developing 3000 R. P. M. When once warmed up, the speed remains constant without detectable variation.

The air current is created by a specially designed impellor of the centrifugal type, geared directly to the motor shaft. This motor will take care of a 6" impellor of aluminium. The speed at the circumference is nearly a mile a minute which is held to be the limit of safety for cast-iron fly wheels, but there is no question that the aluminium impellor could be speeded up much beyond this point without danger.

The air-gate is operated by a worm screw, assuring great precision of adjustment. However, owing to barometric pressure variations, the only safe guide in blowing is the manometer level. The tube of themanometer is heavy-walled

capillary tubing, of two millimeters bore. The meniscus in this narrow bore remains at right angles to the axis of the tube regardless of the inclination of the latter, a great advantage in reading.

This apparatus as presented here is capable of more or less complete standardization but there are three features which must be specially mentioned since they markedly affect the performance. One of these is the grade of bolting silk used to support the seed. Since the manometer in-take is necessarily below the bolting silk (in a relative sence), it records the pressure being applied to the under surface of the latter. The finer the bolting silk the less air gets through it and thus the amount of pressure required to effect a fiven degree of blowing is relatively greater than with an open mesh silk. This is an advantage, since it spreads the manometer readings across a wider scale, thus enabling one to make finer degrees of separation; but it also implies that, for standardization, a standard grade of bolting silk should be used. The others are the diameter of the tube and its height. Naturally, the higher the tube, the heavier is the blowing required to effect a given separation. The greater the diameter, the greater is the porous area of bolting silk exposed to the air current and the greater is the drop of pressure in consequence. Thus, the manometer readings will be lower for a given air current than with a smaller diameter tube.

The tube we use, and the one we would recommend, has an interior diameter of 1-1/4 inches and a height of 23 inches from bolting silk to discharge. The bolting silk has 73 meshes to the inch.

Figures 1 to 10 give detail sketches with all essential dimensions in case others would wish to have similar instruments constructed. Figures 11 and 12 show general views from the front and back respectively.

Figure 1 is a general view from the side with part of the wall cut away to show the positions of the partition, impellor, etc. The partition extends clear from top to bottom and supports a sleeve or cylinder three inches long and six inches in diameter, coaxial with the impellor shaft. The impellor side of this cylinder supports a cowling with a circular hole 2½ inches in diameter. The slope of the cowling conforms to the slope of the impellor blades. The entire job is constructed of welded furniture steel, the only removable parts being the platform on top and the plate on the back face above the step, which are bolted. This plate carries the bearing for the impellor shaft and affords entrance to the interior for adjustment. Continuous with the back face, to which the removable plate is bolted, is a curtain extending clear across the box, and 1½ inches deep. This serves to break the direct line from the impellor to the blower tube seating.

A 3-necked Wolff bottle serves as the manometer reservoir. A large surface area is necessary to avoid material change in level when liquid moves in the manometer tube. The fluid is Kerosene, sp. gr. 0.8, approximately, tinted with Sudan III, as suggested by Dr. Porter. It is almost the ideal fluid, its one draw-back being that the manometer tube must be made in one piece since rubber joints cannot be used.

At the top right of the diagram, marked "A" is shown a small coil spring hooked into the flange on the edge of the platform. This is to hold the blower tube in place, in which it is assisted by a small plate bolted to the top of the platform and cut away to conform to the shape of the blower tube.

Figure 2 gives the details of the impellor. It consists of a circular aluminium plate rivetted centrally to a boss with lock-bolt mounted on the impellor shaft. Rivetted to this plate are eight aluminium blades set at right angles to

the plate and shaped as shown. The cowling, which conforms to the slope of the blades, thus approaching the plate towards the periphery, reduces the free volume in conformity with the increase of pressure of the air when passing from the low pressure to the high pressure side, thus cutting out disturbing eddies and increasing efficiency.

Figure 3 gives details of the impellor bearing which is made of brass. The long bearing imparts rigidity to the set-up while the cut away central portion provides a reservoir for oil and a small enough bearing surface to avoid unnecessary friction. It is held to the removable plate by a lock-nut on the inside.

Figure 4 shows the relative positions of the sleeve and cowling on the partition, with the impellor beyond.

Figure 5 shows the arrangement of the 3-point support.

Figure 6 is a sectional view of the blower-tube seating and the manometer-tube take-off. It will be noted that they are placed as closely as possible side by side. The blower-tube seating consists of three parts: (1) The outer cylinder of heavy brass, which seats itself firmly by its own weight on the opening in the top of the step portion of the box. (2) A brass ring 0.4 of an inch wide made to fit (rather easily) the inside of the cylinder and with the angles buffed smooth to avoid cutting the bolting silk. The latter is stretched over this ring and the cylinder forced onto it. (3) A sleeve similar to the ring, but a tighter fit and 1.2 inches wide. The thickness of the ring and of the sleeve should be the same as the thickness of glass in the blower tube. Thus there will be an uninterruptedly smooth surface from top to bottom of the air-blast. The blower tube Figure 10) should be made of selected soda-glass tubing, calipered outside and in and as truly circular in cross-section as possible. Such tubing can be obtained at slightly increased cost above unselected stock. Cut square at the bottom, the blower tube is inserted in its seating and ground into place using fine emery and turpentine. This is a simple operation and insures uniform contact between the tube and its seating, avoiding lodging of particles.

Soda-glass is specified since other types of glass are too highly electrostatic for use. The discharge should be reduced in diameter to about one inch, starting below the bend. This effects a sudden increase in the linear speed of the air blast, at the point of restriction, ensuring that particles will not lodge in the, approximately, horizontal portion.

Figure 7 shows the relative positions of the blower-tube seating, manometer tube take-off, motor, and spirit level, all situated on the step, with the removable plate behind. The removable plate is held by 14 bolts. Before tightening, a piece of soft string is looped around all the bolts and drawn tight, serving as a gasket.

Figure 8 presents a frontal view showing details of the adjustable manometer scale and of the air-gate which are self-explanatory.

Figure 9 is a cross-section of the air gate. Flat springs are inserted in shallow grooves in the flanges on the sliding plate, between the latter and the guides, which serve to press the face of the plate against the opening to ensure a good seal.

Figure 10 shows the blower tube and cylinder, adapted from the old Kny-Scheerer type of blower.

Performance

The effectiveness of Dr. Porter's proposed method of pure seed analysis de-

pends, to no small extent, on precision of blowing. Not only that, but for any method that blower may be considered superior which most closely controls the blowing operation. The following series of analyses,presented in tabular form, illustrate the limits of the present apparatus in this regard.

Since it was desirable to avoid personal errors as far as possible, no attempt has been made in the present analyses to relate blowings closely to pure seed content; merely the mechanical performance has been studied. The writer believes that Dr. Porter is covering the other phase rather thoroughly.

In Table 1 are shown in millionths of a gram,the mean weights per particle of the material blown over at intervals of one tenth millimetre pressure, except for the first seven readings which are separated by intervals of two tenths millimetre. Two separate grams from the same sample were used and the results given are the averages of the two series.

The sample was placed in the machine and blown at the first reading until no more came over. The portion blown over was then weighed and the number of particles counted. Meanwhile, the pressure was increased to the next reading and the weighing and counting carried out as before on the next separation, and so on to 30 separations.

TABLE 1

MEAN WEIGHT PER PARTICLE OF THE MATERIAL BLOWN OVER AT VARIOUS MANOMETER READINGS - 114 MESH.

Manometer	gms. $x10^{-6}$	Difference	Manometer	gms. $x10^{-6}$	Difference
2.8	24.0		4.9	110.5	5.0
3.0	36.0	12.0	5.0	114.5	4.0
3.2	36.5	0.5	5.1	126.0	11.5
3.4	45.5	9.0	5.2	124.5	-1.5
3.6	59.5	14.0	5.3	137.5	13.0
3.8	67.0	7.5	5.4	134.0	-3.5
4.0	73.5	6.5	5.5	147.5	13.5
4.1	81.5	8.0	5.6	144.5	3.0
4.2	86.5	5.0	5.7	152.5	8.0
4.3	93.5	7.0	5.8	149.5	-3.0
4.4	93.5	0.0	5.9	158.0	8.5
4.5	99.0	5.5	6.0	157.0	-1.0
4.6	103.0	4.0	6.1	163.0	6.0
4.7	108.5	5.5	6.2	168.0	5.0
4.8	105.5	-3.0	6.3	169.5	1.5

Mean difference per 1/10 mm. pressure increase 4.35 X 10^{-6} gms.

Before discussing these results, two points must be mentioned. The only available measure was mean weight per particle, but of course the real measure should have been the mean weight in relation to the surface exposed by the particle to the air current. This accounts in part for the irregularities in these data.

The second is that for work of such a delicate nature, an ordinary chemical balance is hardly fine enough. Since each separation consisted of only a few seeds, a difference of 1/10 mg. will materially alter the mean particle weight. Nevertheless, they afford a good picture of the progressive increase in weight which, plotted on a graph, is seen to be a linear function of the pressure. Each increase in pressure of 1/10 mm. increases the average weight per particle blown over by about 4-1/3 millionths of a gram. Thus we have a very delicate discrimination and a high degree of sensitivity.

This series of results was carried out with bolting silk of 114 mesh. Table 2 presents similar results carried out in duplicate secured with 73 mesh silk and using one gram and half gram samples.

TABLE 2

MEAN WEIGHT PER PARTICLE OF THE MATERIAL BLOWN OVER AT VARIOUS MANOMETER READINGS - 73 MESH.

Manometer Reading	One gram samples		Half gram samples	
	gms x 10^{-6}	Diff.	gms x 10^{-6}	Diff.
2.4	36.0		65.5	
2.6	59.0	23(.2mm	88.5	23(.2mm)
2.7	69.5	10.5 diff)	97.0	8.5
2.8	73.5	4.0	101.0	4.0
2.9	76.5	3.0	109.5	8.5
3.0	85.0	8.5	128.5	19.0
3.1	91.5	6.5	135.0	6.5
3.2	99.0	7.5	135.0	0.0
3.3	112.0	13.0	136.0	1.0
3.4	120.0	8.0	144.5	8.5

Mean difference per 1/10 mm. pressure increase for 1 gm. samples = 8.4 X 10^{-6} gms, for 1/2 gm. samples = 7.9 X 10^{-6}.

It is seen that again there is some irregularity but that the mean difference with the coarser mesh is about twice as great as with the 114 mesh, namely 8 millionths of a gram approximately, and is practically the same whether a one gram sample or a half gram sample has been used. These observations support previous remarks as to the effect of the grade of bolting silk used.

With these points in mind, the writer recommends that a standard grade of 100 mesh metal cloth, with mean diameter of mesh 0.006 inches, be employed in a standardized blower.

Effect of Size of Sample

A series of readings of the manometer for given gate openings, with and without a sample in place gave rather striking results. It was found (1) that at a given gate opening the manometer reading was higher when the sample was in place and (2) that there was a constant difference between the manometer readings at any given gate opening. This constant difference is evidently a measure of the

surface area of the bluegrass exposed to the air current. Now examine Table 2 again and note that for a given manometer reading the mean particle weights are greater for the smaller sample. Since (allowing for a rather large experimental error) unit increases in the manometer reading bring out particles heavier by a constant difference (8×10^{-6} gms), what is happening evidently is that at all readings of the manometer, a unit increase in the reading brings about a unit increase in the speed of the air column in the blower tube. However, obstruction to the air flow is brought in proportion to the size of the sample, that is, to the surface area of the seeds exposed to the air current. This obstruction results in a higher manometer reading, but does not upset the relation between increase in speed of air-flow and increase in manometer reading.

Thus, provided the sample is not too big, the delicacy of blowing is the same for samples of different size but the starting point on the manometer, so to speak, is lower the smaller the sample. All that is needed, therefore, is to determine equivalent starting points for working samples of different sizes if it is found necessary to deviate from the quantity laid down in the rules.

Replicate Blowings

In Table 3 are shown the results of making 10 replicate blowings on a single sample of Poa pratensis at four different pressures. The procedure followed was to blow exactly 10 minutes as follows, using as an example the first pressure:

2.2 mm.	1 min.
2.3 mm.	1 "
2.4 mm.	1 "
2.5 mm.	1 "
2.55 mm.	3 "
2.6 mm.	3 "

TABLE 3

PERCENT HEAVY SEED. REPEATED BLOWINGS AT FOUR DIFFERENT PRESSURES - 73 MESH AND 100 MESH.

	73 mesh		100 mesh	
Pressure	2.6 mm.	2.8 mm.	3.85 mm.	4.1 mm.
Replicate				
1	97.23	95.72	92.73	91.31
2	97.74	95.77	92.57	91.56
3	98.01	95.93 x	92.56	91.60 x
4	97.79	95.89	92.43 x	91.48
5	97.22 x	95.49	92.52	91.50
6	97.97	95.72	92.56	91.51
7	97.84	95.39 x	92.56	91.26 x
8	98.04 x	95.82	92.78 x	91.29
9	97.88	95.58	92.61	91.58
10	97.94	95.48	92.70	91.29
Mean	97.76	95.68	92.60	91.44

x - Highest and lowest readings.

The first two series were made with 73 mesh and the second two with 100 mesh. In the first series, the machine was resting on a table with castors and since it was felt this did not afford a sufficiently firm base, it was afterwards moved to a more solid desk. Nevertheless, the spread is not great--0.82% while in the others the spread has been reduced to 0.54%, 0.35% and 0.34% respectively. This degree of uniformity may, according to the writer's opinion, be considered as very satisfactory.

Two further minor improvements will be incorporated in subsequent models which will enable an even more accurate adjustment to be made. The first is to use a two-bubble spirit level instead of a centre-bubble and the second is to recess the manometer scale to admit the manometer tube to a depth equal to its radius and to extend the markings on the scale on both sides of the manometer tube.

Most of the experimental results were obtained by my assistant, Miss B. M. Gordon, for whose careful and painstaking work sincere appreciation is expressed.

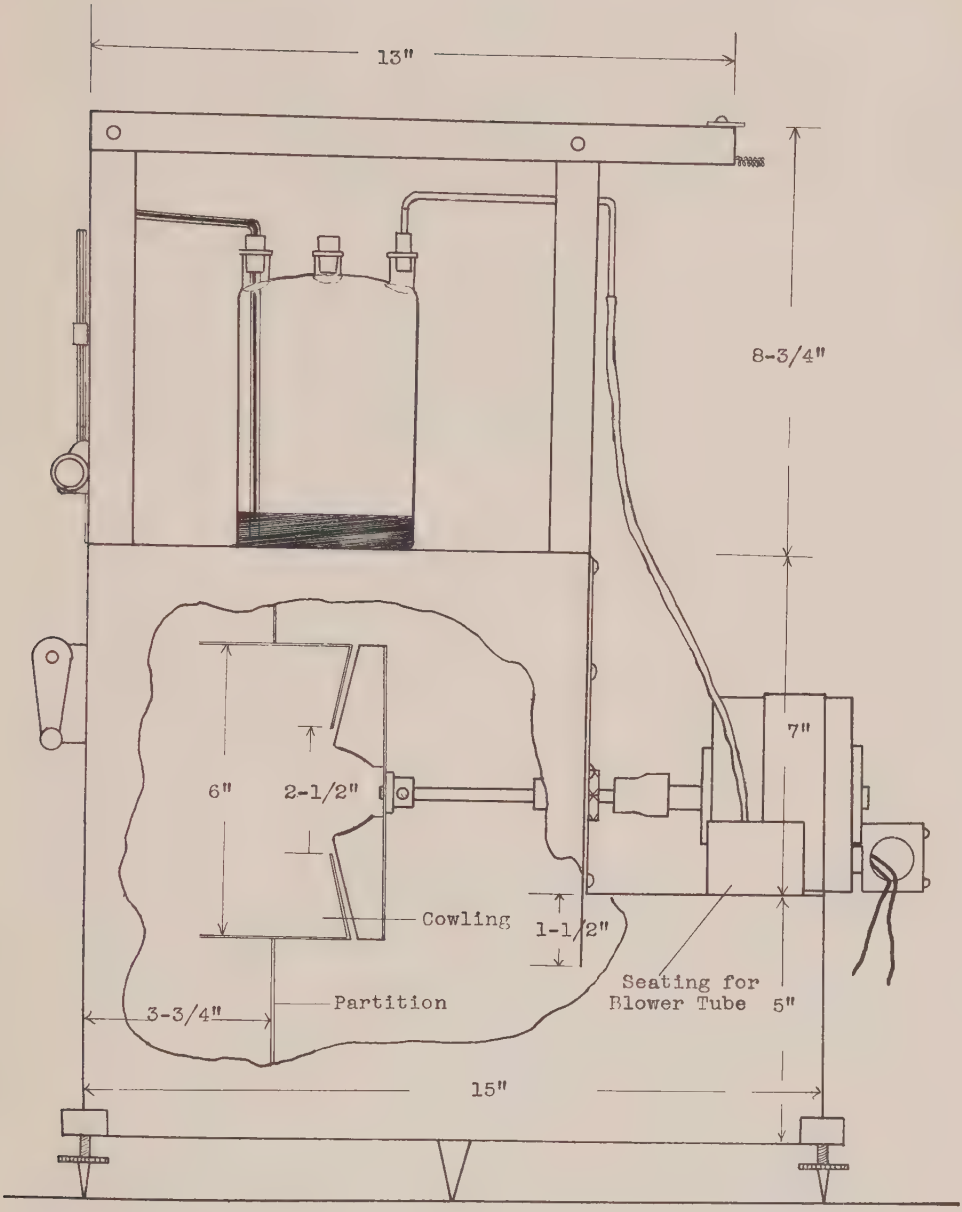


Figure 1. Side Elevation
Part of wall cut away to show arrangement of interior

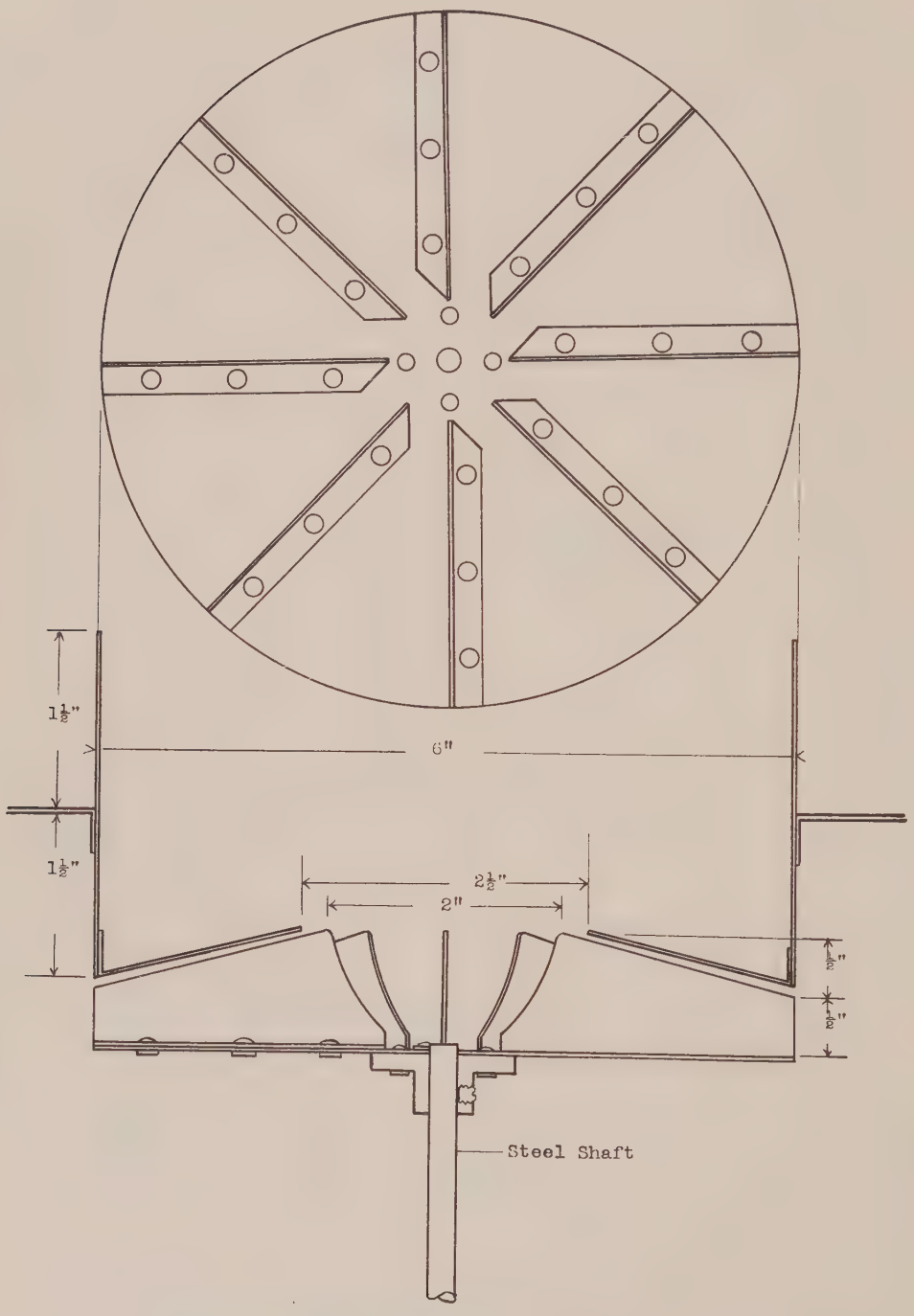


Figure 2. Details of Impellor; aluminium, rivetted.

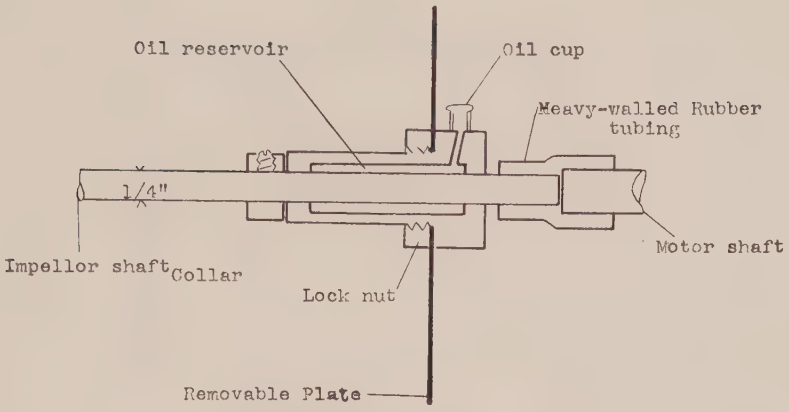


Figure 3. Longitudinal section through impellor shaft, bearing, union and motor shaft.

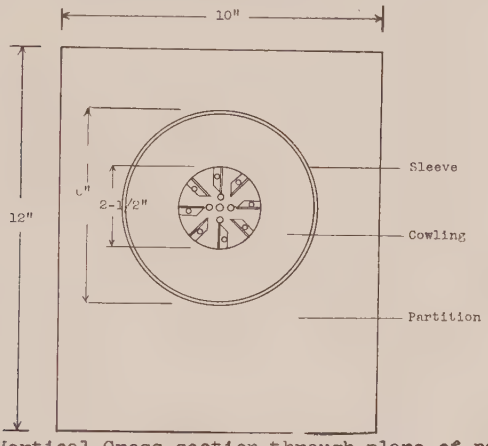


Figure 4. Vertical Cross-section through plane of partition looking towards impellor.

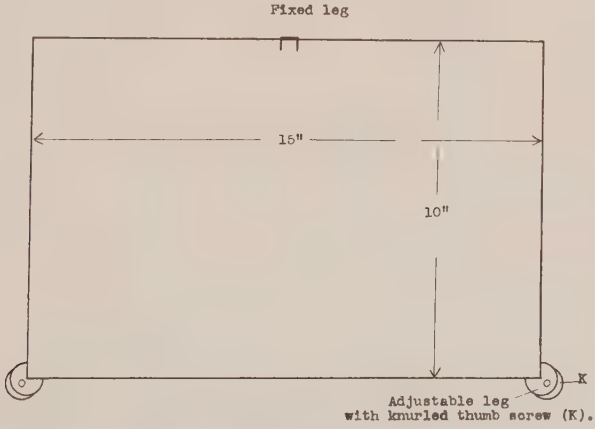


Figure 5. Plan of base to show 3-point support.

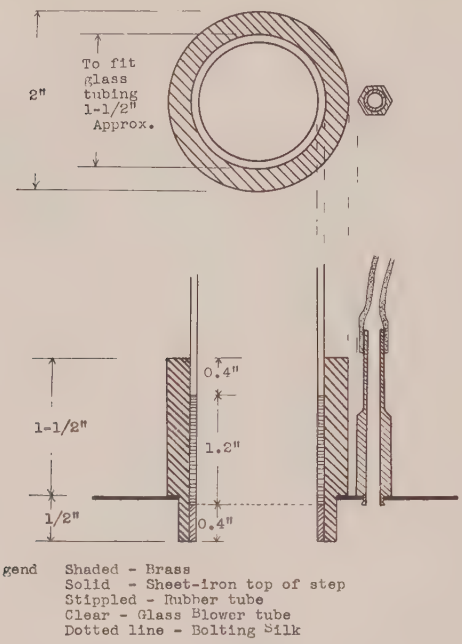


Figure 6. Details of blower-tube seating and manometer-tube take-off. (Plan and section)

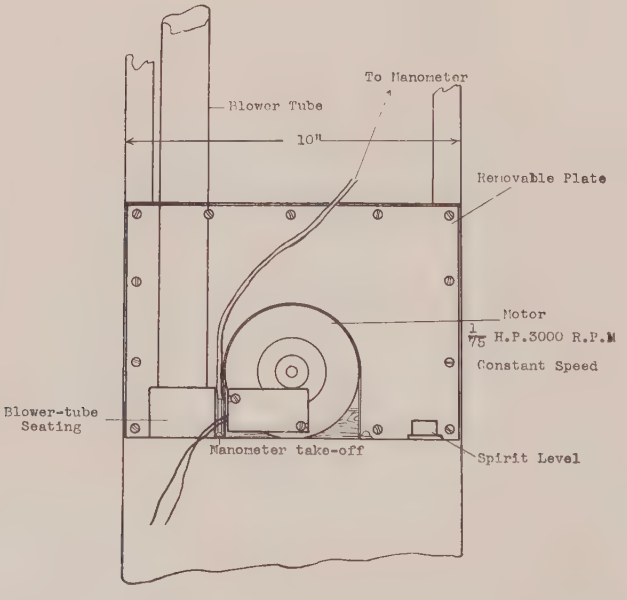


Figure 7. Back elevation
(Top platform and base not shown)

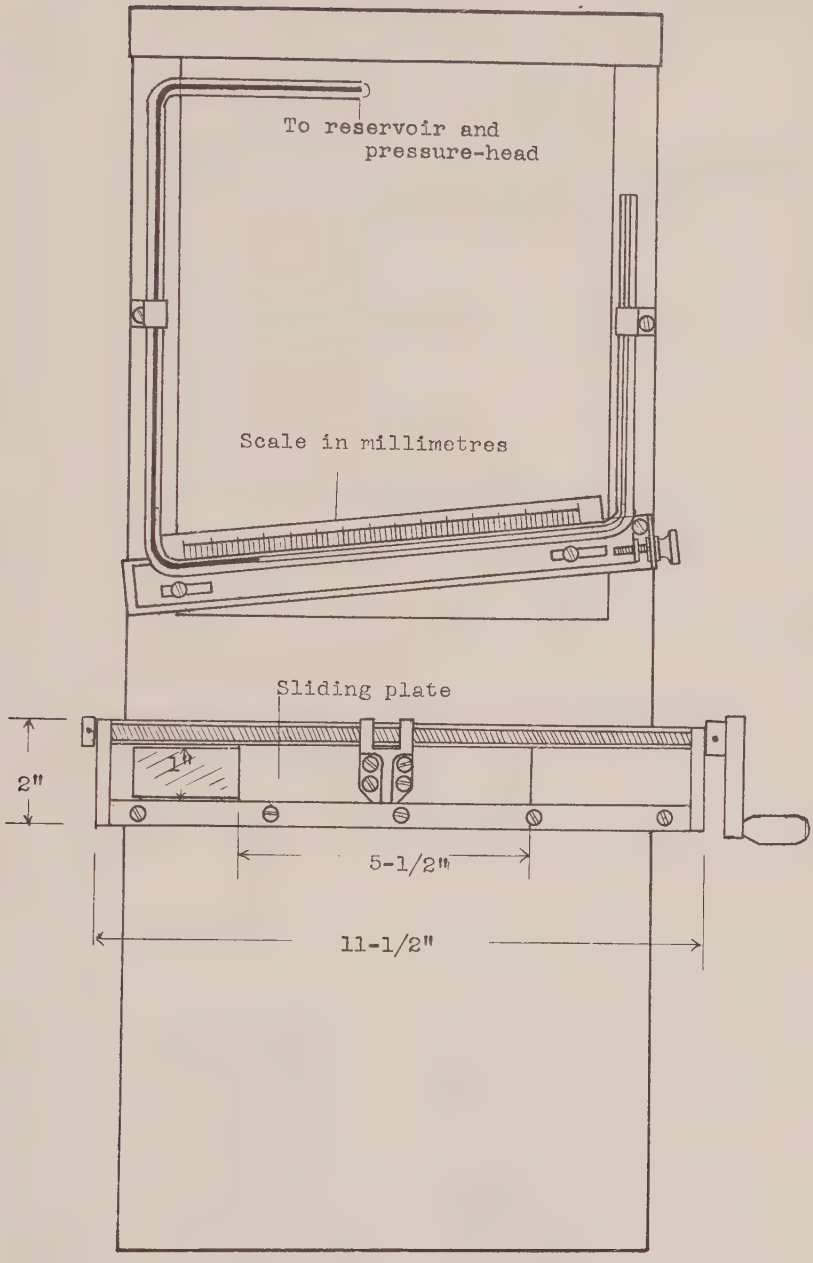


Figure 8. Front Elevation showing Air Gate and and adjustable Manometer Scale.

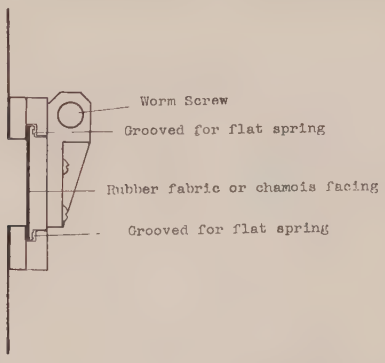


Figure 9. Detail of air gate Cross-section

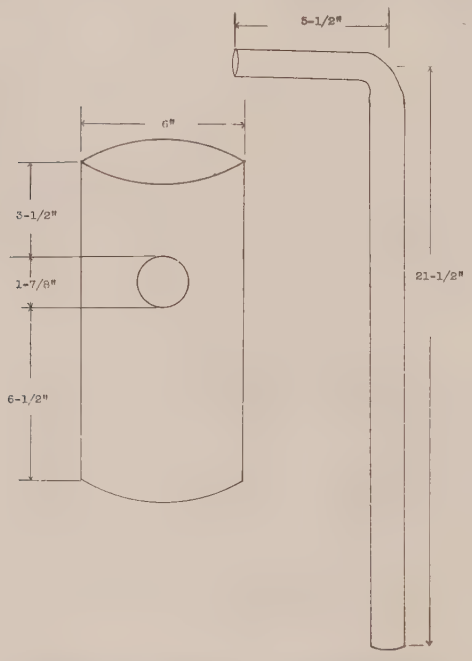
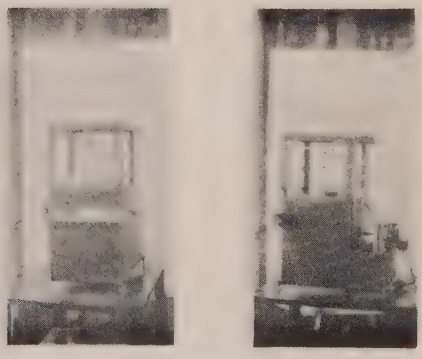


Figure 10. Blower tube and cylinder



Figures 11 and 12, showing front and rear views of the blower.

UNIFORM TECHNIQUES FOR THE ANALYSIS OF SMALL-SEEDED GRASSES[1]

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In a recent paper (6)*data were presented which showed that by the use of a constant speed motor connected to the Holland type air blast separator it was possible to obtain percentages of purity from Kentucky bluegrass subsamples of seed drawn from a given lot with differences no greater than might be expected from homogeneous lots of seed. The chi-square test for homogeneity was used as the measure of significance. A further evidence of uniform separation was exhibited in the germination tests which showed that quadruplicate tests of 100 seeds each from the pure seed fractions of two subsamples gave mean percentages of germination well within the range of natural variability. Reasonable accuracy of separation of fertile and infertile florets was demonstrated by the small number of normal seedlings obtained from the inert fractions when the latter were placed under conditions favorable for germination. When eight subsamples were drawn from a lot, blown in a uniform manner, percentage heavy determined, recombinations made and submitted to eight seed laboratories, with the request that blowings be made until similar separations were obtained, the final results were sufficiently uniform to indicate no significant differences.

The attachment of a manometer to determine pressure, as suggested by Leggatt (5), showed that at any given opening of the dial the static pressure as maintained by the fan was uniform, a condition which undoubtedly explains why such uniform results have been obtained in previous investigations.

The results of all the analyses made thus far in the Iowa Laboratory with bluegrass samples ranging in weight from 10 to 27 pounds per bushel, as well as published reports of referee samples (1,2) conducted by the Research Committee of the Association, definitely show that the determination of absolute purity of bluegrass seed is a practical impossibility and that an empirical, uniform method which eliminates, as much as possible, errors of human judgment, is to be preferred.

Working with orchard grass, Seiferle and Porter (7) developed a modified method of purity analysis which not only shortened the time required in comparison with the official method, but gave far more uniform results as shown by referee analyses (2), than are obtained by different laboratories using the official method with similar subsamples of seed. Separations were first made into heavy and light fractions by the air blast separator after which single and multiple florets were removed separately from the heavy portion, one-fifth of the weight of the multiple florets was added to the inert fraction and four-fifths to the weight of the pure seed.

The Holland air blast separator has certain disadvantages, one of which is the lack of fine adjustment of the air valve. A second drawback lies in the use of bolting cloth in the base of the seed cup and in the cap at the top of the

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[2] The writer gratefully acknowledges the faithful and valuable assistance of Wayne A. Robbins who carried out much of the detail involved in the investigations and also the assistance of I. A. Coleman who made the air blast separator.
* Numbers in parenthesis refer to Literature Cited.

tube. Seeds become attached to the cloth in the cup, making removal difficult, and much lint and dirt accumulate on the cloth at the cap, causing irregularity of pressure in the tube. Frequent cleaning of the cloth as well as replacement is necessary.

In September, 1937, an air blast separator was designed by the writer and constructed in the Iowa State College Instrument Shop. The external features are illustrated in Figure 1. The essential features are:

1. A valve and a dial as illustrated at "a".
2. A compression chamber "b" with a valve for attachment to a manometer.
3. A cap "c" for the chamber with a seed cup about one inch in diameter at the bottom of which is a 100-mesh copper screen.
4. An 18-inch copper tube one inch in diameter with an adjustable trap in which the light weight fraction may be caught. An attachment for a manometer was also installed in order to determine pressure in the tube.
5. A cap "e" with a 100-mesh copper screen to prevent loss of any portion of a sample, yet permit free escape of air.
6. A manometer, with a vertical tube and a scale graduated to one millimeter. Kerosene, specific gravity 0.792, colored with Sudan III, was used in the tube. Later a second manometer was constructed with the glass tube at a 30° angle with the horizontal, equipped with a sliding steel rule graduated in one-half millimeters and an adjustable magnifying lens. The surface tension of the liquid in the one-millimeter tube was found to be greater than the force of gravity, hence the meniscus lay at an angle instead of horizontal, which permitted easy reading. Furthermore, by slanting the tube at an angle of 30°, the length of the hypotenuse of the triangle is twice the length of the vertical leg, thereby making a distance of one-half millimeter on the diagonal scale equal to one-fourth millimeter on a vertical scale. A level was clamped to the upper edge of the board on which the tube was mounted.

Following the construction of the separator and its accessories, a series of experiments were undertaken with many samples of bluegrass seed, the purpose being to determine (a) accuracy and uniformity of separation and pressures at which fertile florets may be blown out with inert material, (b) relation of manometric readings to dial readings, (c) bushel weight of small working samples, (d) variation among subsamples as drawn by the Boerner sampler, and (e) application of techniques to laboratory practice. Experiments were also undertaken with orchard grass and redtop seed samples.

A major objective was the development of standard equipment that could be depended upon to make uniform separations and thus aid in a determination of the causes for wide differences in purity analyses of bluegrass and orchard grass seed. From such a study it is hoped that possible assistance may be rendered in solving some of the analytical and labeling problems which have long existed.

EXPERIMENTAL RESULTS

Accuracy of Separation

To test the accuracy of separation, a synthetic sample of bluegrass seed was prepared in the following manner. From a seed sample with a bushel weight of 27 pounds, a one-gram sample was drawn and blown for 10 minutes at a pressure known to be slightly higher than necessary to remove all infertile florets. Foreign material was then removed and 800 milligrams of the heavy pure seed was

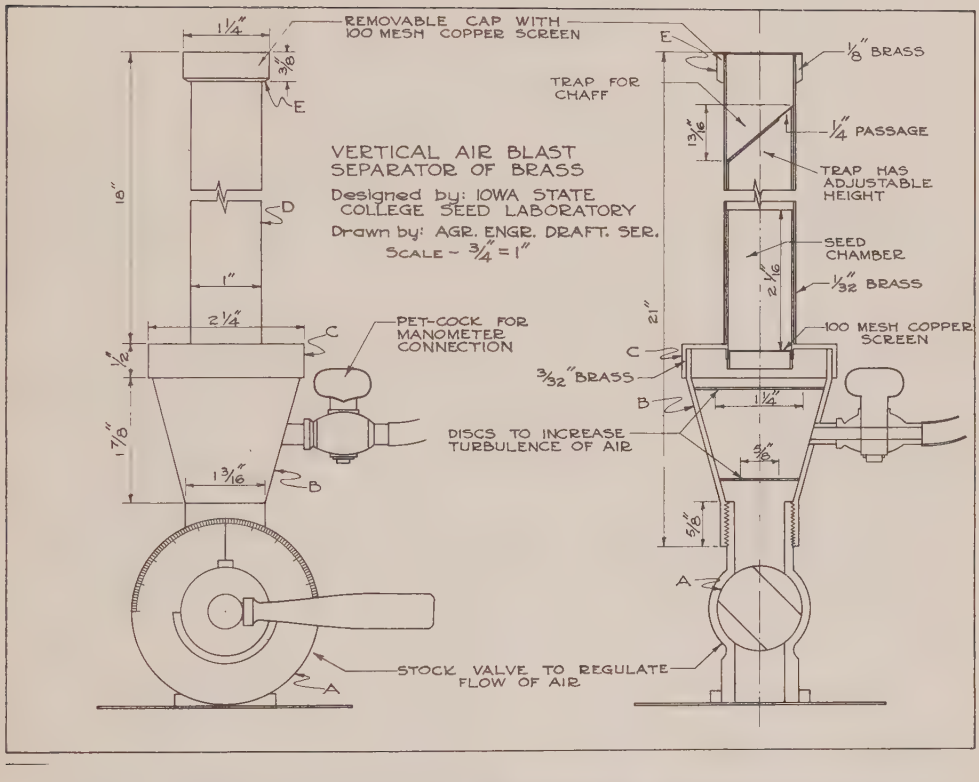

Figure 1. Diagram of Iowa air blast seed separator designed and tested by the Iowa State College Seed Laboratory.

weighed and set aside. From a seed sample with a bushel weight of 10 pounds, a one-gram sample was drawn and blown at a pressure known to be too low to remove fertile florets. From the chaff thus blown out, 200 milligrams containing only infertile bluegrass florets was weighed, stained with an alcoholic solution of safranin, dried and then added to the unstained pure seed fraction of 800 milligrams. The one-gram synthetic sample was then placed in the cup of the separator and subjected for 15 minutes to air pressures ranging from six to nine millimeters. At the end of the period the heavy and light fractions were examined for the presence of stained and unstained florets. Repeated trials were made with the same sample blown at the same pressures as well as the same dial setting. The results of eight trials are shown in Table 1.

TABLE 1
SEPARATION OF FERTILE AND INFERTILE FLORETS OF BLUEGRASS BY UNIFORM AIR PRESSURE.

	Replications								
	1	2	3	4	5	6	7	8	Mean
Number stained in heavy fractions	4	6	2	4	5	2	3	2	3.5
Number unstained in light fraction	2	2	8	6	4	3	1	2	3.5

To adequaltely interpret the results of the tests shown in Table 1, it should be understood that the synthetic sample contained approximately 3,840 unstained fertile florets and at least 2,400 stained infertile florets. An air blast separator which is capable of separating as accurately as the data indicate was considered adequate to use in subsequent experiments. However, it is important to note that commercial samples of bluegrass seed do not consist entirely of florets that are so sharply defined in weight as those in the synthetic sample, that is, a sample will usually contain heavy florets, extremely light florets and several gradations between the extremes which are difficult to classify. It is this group which falls between the extremes that causes difficulty in classification, yet controlled air pressure should be and has been shown to be more uniform than human judgment in making a separation.

Uniformity of Separation by Iowa Air Blast Separator

To further test the uniformity of separation by the air blast separator, duplicate subsamples of bluegrass seed were drawn from each of 16 lots, the first nine sets of duplicates being obtained by sub-division of each lot down to a two-gram portion which was then divided into two subsamples, the last six sets being drawn in such a manner that one member of each pair was obtained by subdivision of one-half the initial lot and the second member of the pair from the other half of the lot. The object of the two methods of drawing the duplicate subsamples was to check the divider. Blowings of each subsample were then made according to the following schedule:

Time	Pressure	Samples
Min.	mm.	
1	6.0	All samples
1	7.0	All samples
8	8.0	All samples
5	8.5	27-28 pound seed
7	8.5	23-26 pound seed
10	8.5	20-22 pound seed
13	8.5	16-19 pound seed
15	8.5	10-15 pound seed
3	9.0	All samples

At the termination of each period at a given pressure, the amount removed was weighed and placed in a petri dish with a moist blotter as the substratum. All the dishes were kept at alternating temperatures of 20° to 30° C for 21 days, and the number of normal sprouts in each dish was counted and removed at 9, 15, and 21-day periods. In addition, the heavy portion was examined for multiple florets or for entire spikelets in which there was no fertile floret, such were removed and placed in a dish for a germination test. The results of the tests with the respective inert fractions are presented in Table 2 in which the number of sprouts obtained is given.

The data in Table 2 indicate two important points, namely, (a) the number of normal sprouts from each member of a pair is similar with the exception of samples 4, 10, 11, and 12: and (b) the pressure at which an appreciable number of fertile florets is removed is close to eight millimeters, the major portion of the florets being removed at 8.5 and 9.0 millimeters when approximately one gram of seed was used.

Another point which deserves mentioning is that although the number of fertile florets removed from each member of a pair was fairly uniform, many more were removed from some samples than from others. The reason for this is not definitely known, but the variation among lots in the percentage of shriveled and immature yet viable florets would definitely affect the number of fertile florets removed at the higher pressures, depending upon the length of time the samples were blown.

The relation of weight of sample to percentage of pure seed is illustrated in four cases in Table 2. Samples 2 and 10 were drawn from the same lot, likewise samples 3 and 12, 8 and 14, and 9 and 15. The mean purity of samples 2a and 2b is significantly lower than of samples 10a and 10b, and the mean weights of the pairs are 0.830 and 1.104 grams, respectively. The mean purities of samples 3, 8, and 9 are lower than those of sample 12, 14, and 15, respectively, but the difference is not significant as between samples 3 and 12. In all cases the mean purity of the pairs with the higher weight of working sample was greater than of those with the lower weight of working sample. The reason for this condition will be shown later.

Conclusions which may be drawn from the above experiments are:
(a) the differences in purity of pairs from the same lot were not significantly different in any case, and (b) an appreciable number of viable florets was not removed until the pressure was increased above eight millimeters. Furthermore the largest number of viable seeds removed from any one sample was 84, which would be equal to about 12.5 milligrams. On the basis of 0.875 grams for the working sample, the removal of 84 good but light weight seeds would reduce the

TABLE 2.
NUMBER OF SPROUTS OF BLUEGRASS FROM INERT FRACTIONS REMOVED AT DIFFERENT PRESSURES.

Sample No.	Wt. per bushel lbs.	Wt. working sample gms.	Pure seed %	Number of sprouts in fractions removed by pressure, mm. 6 & 7	8	8.5	9	By hand	Total
	Duplicates from subdivision of approximately two grams								
1 a	10.0	0.740	6.5	1	1	9	7	2	20
b		0.731	6.8	-	2	23	9	-	34
2 a	15.0	0.816	52.8	3	3	13	15	-	34
b		0.844	54.7	-	4	13	3	-	20
3 a	19.0	1.087	75.1	-	-	1	18	-	19
b		1.075	76.4	-	-	1	13	-	14
4 a	19.5	1.027	82.0	-	11	21	4	1	37
b		1.071	81.6	-	11	38	28	2	79
5 a	20.0	0.920	82.4	2	11	22	11	-	46
b		0.947	83.3	-	6	6	33	-	45
6 a	20.5	0.923	82.9	1	4	10	3	1	19
b		0.965	83.6	-	6	5	7	-	18
7 a	20.5	1.084	85.9	-	1	4	3	1	9
b		1.116	86.3	-	1	1	2	-	4
8 a	22.5	1.107	88.5	-	1	18	25	1	45
b		1.036	88.7	-	9	23	20	1	53
9 a	26.5	1.009	97.1	-	-	1	3	-	4
b		1.043	96.7	-	1	2	1	-	4
Average				.08	2.6	7.8	5.7	3.0	19.3
	Duplicates from subdivision of each initial half								
10 a	15.0	1.029	59.1	-	-	1	1	2	4
b		1.180	58.6	-	-	7	7	8	22
11 a	17.5	0.875	81.0	-	19	14	19	2	84
b		0.839	83.4	-	11	13	12	5	42
12 a	19.0	1.267	78.2	-	-	5	1	4	10
b		1.167	75.5	-	-	19	20	2	41
13 a	21.5	1.061	87.4	-	-	3	3	-	6
b		0.997	87.1	-	-	1	2	2	5
14 a	22.5	1.161	92.7	-	-	1	1	3	5
b		1.113	92.1	-	2	-	2	1	5
15 a	26.5	1.220	97.7	-	-	-	-	1	1
b		1.144	97.3	1	-	-	-	5	6
Average				.2	4.0	10.6	10.8	.5	28

purity about 1.4%. The average number removed in either set was sufficient to cause between 0.3 and 0.4% reduction in purity.

Additional data from the experiments with 15 samples listed in Table 2 are presented in Table 3, showing the percentage by weight of inert fractions removed at different pressures as well as by hand from the heavy fraction. Only

TABLE 3.
UNIFORM SEPARATION OF INERT MATERIAL FROM BLUEGRASS SEED AT DIFFERENT PRESSURES.

Sample No.	Inert matter at millimeters pressure				Inert matter hand picked	Pure seed	Inert matter	Weed seeds	Difference in pure seed	Mean purity
	6 & 7	8	8.5	9						
	%	%	%	%	%	%	%	%	%	%
1 a	48.5	37.0	5.7	1.4	0.7	6.5	93.2	0.3	0.4	6.7
b	55.0	29.7	6.8	1.2	0.4	6.8	93.2			
2 a	20.3	21.6	2.5	1.2	1.4	52.8	46.9	0.2	1.8	53.7
b	15.8	21.6	5.0	0.7	2.1	54.7	45.1	0.1		
3 a	3.1	2.7	11.0	4.7	3.3	75.1	24.8	0.2	1.3	75.7
b		9.5	5.5	4.0	3.4	76.4	23.0	0.7		
4 a	4.3	8.7	3.1	0.9	0.9	82.0	17.8	0.2	0.4	81.8
b	4.0	8.7	3.1	1.5	0.8	81.6	18.2	0.2		
5 a	8.4	4.2	1.6	0.8	0.5	82.4	15.5	2.1	0.9	82.9
b	6.0	6.6	1.0	1.4	0.5	83.3	15.3	1.4		
6 a	8.1	3.8	0.8	0.4	3.5	82.9	16.6	0.5	0.8	83.3
b	7.5	3.4	0.8	0.5	3.9	83.6	16.2	0.2		
7 a	4.5	6.7	1.5	0.5	0.8	85.9	14.0	0.1	0.4	86.1
b	4.6	6.2	1.3	0.5	1.0	86.3	13.5	0.2		
8 a	1.5	4.5	2.8	1.4	1.0	88.5	11.1	0.3	0.1	88.6
b	2.3	5.1	1.5	1.0	1.1	88.7	11.1	0.3		
9 a	0.2	1.2	0.2	0.2	1.0	97.1	2.8	0.1	0.4	96.9
b	0.2	1.3	0.3	0.2	1.1	96.7	3.1	0.1		
10 a	5.0	22.2	7.3	2.9	3.5	59.1	40.8	0.1	0.5	58.9
b	2.0	23.2	10.0	3.1	2.8	58.6	41.2	0.2		
11 a	4.7	8.0	2.9	1.0	1.9	81.0	18.5	0.5	2.4	82.2
b	2.0	6.1	2.6	1.7	3.0	83.4	15.7	0.8		
12 a	4.3	9.3	3.3	1.2	3.2	78.2	21.3	0.4	2.7	76.9
b	2.7	9.3	7.7	1.5	2.7	75.5	23.9	0.6		
13 a	4.0	5.7	1.3	0.7	0.9	87.4	12.5	0.1	0.3	87.2
b	4.5	5.4	1.5	0.7	0.7	87.1	12.8	0.1		
14 a	0.2	1.7	1.2	0.8	3.2	92.7	7.1	0.3	0.6	92.4
b	0.3	2.7	1.1	0.9	2.6	92.1	7.5	0.4		
15 a	0.1	0.3	0.3	0.3	1.2	97.7	2.1	0.2	0.4	97.5
b	0.1	0.3	0.3	0.6	1.3	97.3	2.5	0.2		

multiple florets and spikelets considered to be empty were removed by hand. In general, the degree of uniformity in the removal of inert material by the air blast separator as shown by paired samples is high, a condition resulting, undoubtedly from the fact that the difference in weight of duplicate or paired samples was not large in any instance.

Relation of Manometric Pressure to Dial Reading

In the discussion of the data in Table 2, reference was made to the fact that a considerable difference in weight of samples drawn from the same lot resulted in significant differences in purity even though the same pressure was

used for the same period of time, a result which was in contrast to the data obtained in a previous paper (6) when dependence was placed on a given opening of the valve as measured by the dial to obtain separation of light from heavy.

To test the reliability of the dial reading versus manometric pressure, two sets of experiments were conducted. In the first set a subsample of seed was drawn from a commercial lot with a test weight of 22.5 pounds. The sample was drawn to weigh approximately one and one-third grams so that three-fourths would weigh nearly one gram. The actual initial weight was 1.284 grams, which was blown according to the schedule previously referred to with pressures ranging from 6 to 9 mm. on the vertical manometer. At the completion of the blowing period the purity test was completed without removing any bluegrass florets from either fraction after which weighings and calculations were made. The fractions were recombined and divided so that three-fourths of the original sample was obtained and the same procedure as above was followed, likewise one-half the original sample was then obtained and the same technique used as for the heavy sample. While the separator was in operation, a dial reading was made at each pressure. The results are shown in Table 4, from which it may be noted that as the weight of sample was increased, the dial reading at a given pressure decreased and the purity increased. The difference between the purities 85.40 and 87.72 is significant in that the probability based on chi-square was found to be less than 0.01.

Following the completion of the tests reported in Table 4, the original sample was recombined and blown, using the dial readings recorded for the sample which weighed 1.018 grams as the guide. Pressure readings were taken, the purity completed, weighings made, and all parts recombined after which one-half of the original sample was treated in the same manner. The data are given in Table 5, which shows that the purity percentages were not significantly different, but the pressures obtained from blowing the heaviest sample were higher than those from the lightest sample.

TABLE 4.
PURITY OF SAMPLES OF DIFFERENT WEIGHTS WHEN SEPARATION WAS BASED ON MANOMETER READINGS.

Weight of sample	Dial readings at respective pressures in mm.					Purity
	6.0	7.0	8.0	8.5	9.0	
gms.						%
0.630	19.5	20.2	20.9	21.3	21.7	85.4
1.018	19.0	19.6	20.3	20.7	21.1	87.7
1.286	18.6	19.4	20.1	20.5	20.9	88.0

TABLE 5.
PURITY OF SAMPLES OF DIFFERENT WEIGHTS WHEN SEPARATION WAS BASED ON DIAL READINGS

Weight of sample	Purity	Pressure readings at respective dial readings				
		19.0	19.6	20.3	20.7	21.1
gms.	%					
0.616	87.01	5.3	6.2	7.1	7.8	8.6
1.018	87.72	6.0	7.0	8.0	8.5	9.0
1.282	86.74	6.0	6.8	7.8	8.3	9.1

Further experiments were then conducted, using a synthetic sample consisting of 1.7 grams of heavy selected seed and 0.3 grams of light weight stained florets, the percentage of unstained florets being 85. After using this sample to compare the effect of depending on pressure or dial readings the stained portion was separated and a one-gram sample with the same percentage heavy was prepared, likewise samples weighing 1.5 and 0.5 grams were synthesized.

In these latter analyses the pressure chamber was connected to the manometer with the inclined tube, the petcock on the separator tube was connected to the vertical manometer and both sets of manometric readings as well as dial readings were recorded.

The blowing schedule which had been tentatively adopted for general use was somewhat modified from that shown on page 137, and was as follows:

Time in Minutes	Pressure in mm. Inclined manometer
1	10.0
1	12.0
8	14.0
5	14.5
5	15.0
3	15.5
2	16.0

Synthetic samples weighing 0.5, 1.0, 1.5, and 2.0 grams were blown separately according to the above schedule and the amount removed by the air blast was weighed and examined for unstained florets. The results obtained, together with the respective dial readings and pressure readings in the separator tube, are given in Table 6. The data show that for the half-gram sample, separation was accurate, nearly accurate for the one-gram sample, but that the pressures for the 1.5 and 2-gram samples were inadequate for correct separation.

In Table 7 are shown the data when separation was based on dial reading with approximately two minutes at each opening. The separation for all four weights is exceptionally accurate, thus substantiating the reliability of the data presented in a previous paper (6) when separation was based entirely on dial readings as the guide. No fertile florets were found in the light fraction from any of the synthetic samples when dial readings were used as the basis for separation.

If the voltage be the same in all laboratories and be maintained constant, the writer is of the opinion that dependence on the dial reading as a guide would be preferable, however, if samples nearly one gram in weight are used, pressure as measured by the manometer is a reliable guide. It is also possible to use the manometer merely as a daily indicator to test the particular pressure at a given opening of the dial, using a standard weight of seed in the cup when the test is made.

The different pressure readings in the chamber, when the weight of seed is varied, is due to the fact that the pressure in the chamber is dependent both on the amount of air delivered by the fan and on the resistance in the tube which increases as the weight of sample increases. At any given opening of the dial, the static pressure is constant unless the voltage is too variable. The manometer should be a fairly good substitute for a voltage regulator.

TABLE 6.
EFFECT OF WEIGHT OF SAMPLE ON AMOUNT REMOVED FROM SYNTHESIZED SAMPLES WHEN PRESSURE IN COMPRESSION CHAMBER IS USED AS THE CRITERION.

Weight of sample grams.	Dial readings at different pressures, mm.							Pressure in separator[1] tube at different pressures in chamber, mm.					Weight removed grams	Weight of stained placed in sample, grams
	10.0	12.0	14.0	14.5	15.0	15.5	16.0	10.0	12.0	14.0	15.0	16.0		
0.500	18.0	18.8	19.6	19.7	20.0	20.1	20.3	3.0	3.7	4.5	5.0	5.5	.075	.075
1.000	17.6	18.7	19.3	19.4	19.6	19.9	20.1	2.7	3.4	4.2	4.8	5.3	.139	.150
1.500	17.2	18.1	18.9	19.1	19.3	19.6	19.8	2.1	2.8	3.7	4.3	4.5	.180	.225
2.000	16.3	17.5	18.3	18.5	18.8	18.9	19.2	1.9	2.6	3.5	3.9	4.3	.137	.300

[1] Connected with inclined manometer.

TABLE 7.
EFFECT OF WEIGHT ON PURITY OF SYNTHETIC SAMPLE WHEN DIAL READING IS USED AS THE CRITERION.

Weight of sample grams	Pressure in chamber[1] at different dial readings, mm.					Pressure in separator[2] tube at different dial readings, mm.					Weight	
	17.0	18.0	19.0	20.0	21.0	17.0	18.0	19.0	20.0	21.0	grams removed	stained placed in sample, grams
0.500	7.5	10.0	12.5	15.0	18.5	2.4	3.0	4.1	5.1	6.3	.076	.075
1.000	8.5	10.5	13.5	16.0	19.0	2.1	2.9	3.9	4.9	6.0	.1497	.150
1.500	10.0	12.0	14.3	17.0	20.0	2.2	2.9	3.9	4.9	6.0	.224	.225
2.000	11.0	13.5	15.5	18.0	21.5	2.1	2.9	3.9	4.9	6.0	.2997	.300

[1] Connected to inclined manometer.
[2] Connected to vertical manometer.

To test the reliability of pressure as a guide in the analysis of bluegrass when different purities were involved, six synthetic samples were prepared, each weighing exactly one gram but composed of different proportions of heavy seed and light weight empty florets that were stained with safranin. The ratios by weight of heavy to stained for the six samples were 30 to 70, 50 to 50, 75 to 25, 85 to 15, 90 to 10, and 95 to 5, respectively.

Blowings were made for each sample for two minutes, each at pressures of 12, 14, 15, 16, 17, and 18 millimeters. Dial readings were recorded at each pressure and at the close of the 12-minute period for each sample the fraction removed was weighed and examined for heavy seed. In no instance was heavy seed blown out. The data obtained are shown in Table 8.

TABLE 8.
SEPARATION OF SYNTHETIC SAMPLES OF BLUEGRASS WITH DIFFERENT DEGREES OF PURITY BY CONSTANT AIR PRESSURE. WEIGHT OF EACH SAMPLE EQUALS 1.00 GRAM.

Sample and ratio of heavy to light	Bushel weight, pounds	Dial readings at pressures in mm.						Weight Removed grams	Wt. stained placed in sample grams	Pure by separator
		12	14	15	16	17	18			%
30-70	13.6	18.7	19.5	19.9	20.6	20.9	21.1	.6895	.7000	31.1
50-50	14.8	18.7	19.3	19.8	20.2	20.5	21.0	.4950	.5000	50.5
75-25	19.6	18.6	19.2	19.6	20.0	20.2	20.6	.2380	.2500	76.2
85-15	22.3	18.6	19.3	19.7	20.0	20.3	20.9	.1475	.1500	85.3
90-10	23.8	18.6	19.3	19.8	20.0	20.3	20.9	.0995	.1000	90.1
95- 5	25.7	18.6	19.3	19.8	20.0	20.3	20.9	.0500	.0500	95.0

The results of the experiments as recorded in Table 8 indicate fairly uniform separation of light from the heavy fraction in samples of equal weight when the same pressures are used for each sample. Dial readings were not so accurate as the manometer readings because graduations on the dial are larger than those on the manometer scale. It seems highly probable, however, that if the final opening of the dial for the last four samples had been at 21.0 the separation would have been more accurate, yet the largest error was 1.2%, which is much smaller than may be expected from the judgments of different analysts.

Actually the valve was later opened until the dial reading was 21 for the samples with 75 to 85% pure seed and within three minutes all but three of the stained florets were removed from each sample. When the dial was set for 3 minutes at 21.1 for the sample with 50% pure seed, all but 5 stained florets were removed. The sample with 30% pure seed was blown 5 minutes more with the valve at 21.1 and all stained florets were removed. It is evident that a slightly higher maximum pressure is required for low quality samples as was indicated in a previous paper (6).

Inasmuch as most commercial bluegrass samples are 80% pure or higher, the use of pressure as a criterion in separation must be considered as dependable when nearly the same weight is used for all samples. Even for low quality samples the separation is uniform.

To further test the uniformity of separation by the Iowa Air blast separator, a subsample of bluegrass seed weighing 1.008 grams was drawn from a lot with a bushel weight of 22.5 pounds. The sample was blown one minute at 12, one

minute at 14, five minutes at 15, five minutes at 16, and two minutes at 17 mm. pressure (inclined manometer). It was known that the above schedule would not remove so much foreign material as the schedule on page 141. At the close of the period, the weights of the heavy and inert fractions were found to be 0.896 and 0.111 grams, respectively. The inert fraction was then stained with safranin, dried, weighed and recombined with the heavy fraction, weights of each at the time of recombination being 0.8998 and 0.1135 grams, respectively, or a total of 1.0133 grams. The subsample was twice subjected to the same blowing schedule used before staining of the inert fraction with the following results:

	Weight heavy	Weight inert	Total weight	Percent heavy
First test	0.8996	0.113	1.0126	88.84
Second test	0.900	0.111	1.0110	89.02

Examination of the heavy and inert fractions revealed, as was expected, that several stained particles were present in the heavy fraction and several unstained in the inert fraction. The explanation of the above condition is that at the initial blowing before the inert fraction was stained, not all inert had been removed, hence, when resubjected to the air blast some unstained particles equal in specific gravity to stained particles were removed, and some stained particles remained in the heavy, both results being caused by chance separation.

The difference of 0.18 in percentage heavy may well be expected because of changes in weight caused in part by possible drying of the particles during the period of blowing. A conclusion which seemed logical was that the same degree of uniformity could be expected with laboratory service samples as was shown for synthetic samples. When the sample in question was blown at a slightly higher pressure, all the stained particles were removed with a few other unstained particles of inert which it was not expected would have been removed in the first exposure because the period of time and the pressures used were not adequate.

A second sample with a purity of about 68% was selected and a subsample which weighed 1.040 grams was drawn and analyzed twice, using the schedule on page 163. The only hand work which was done was to remove, from the heavy fraction, weed and crop seeds and all other foreign material but no bluegrass florets. The final weight at the conclusion of the first and second analysis was 1.0345 and 1.0330 grams, respectively. The purity as determined each time was 67.97%, the weight of pure seed being 0.7032 and 0.7021 grams, respectively.

Because of the difficulty of handling the same subsample repeatedly and the danger of losing particles when handling them with tweezers, a slight modification in procedure was made to test the uniformity of separation when the same sample was analyzed more than once. A subsample was drawn from each of two lots, with purities approximating 68 and 88%, respectively. Each was weighed and blown according to the schedule on page 154. From the light weight fractions, all material other than bluegrass florets was removed and enough additional empty florets added to or substracted from each fraction so that when recombined with the heavy seed the purities were approximately 69.5 and 88.5%, respectively, and each weighed one gram. Each subsample was then subjected several times to the same procedure used to make the initial separation. This method made it unnecessary to remove any material by hand from the heavy fractions, the weights of each fraction being determined at the close of each treatment in the separator. The method or modification was chosen to reduce the possibility of loss of any particles. The percentage heavy and the percentage pure may be considered the same

in this experiment. The data obtained from the several tests are given in Table 9.

TABLE 9.
RESULTS OF REPEATED TESTS OF THE SAME SAMPLE FROM EACH OF TWO LOTS, USING IOWA AIR BLAST SEPARATOR

Trials	Sample A Weight Grams			Percent heavy	Sample B Weight grams			Percent heavy
	Heavy	Light	Total		Heavy	Light	Total	
1	.6847	.2995	.9842	69.57	.8879	.1135	1.0014	88.66
2	.6834	.2993	.9827	69.54	.8884	.1131	1.0015	88.71
3	.6770	.3008	.9777	69.25	.8847	.1129	.9976	88.68
4	.6772	.3009	.9771	69.20	.8843	.1119	.9962	88.77
5	.6774	.2998	.9772	69.32	.8817	.1130	.9946	88.64
6	.6750	.3001	.9751	69.22				
7	.6787	.2984	.9771	69.46				
Mean				69.37				88.69

Samples A and B prepared May 15, 1938. Sample A tested between 1:00 and 5:00 p.m. May 29, 1938. Sample B (land 2) tested 7:00 - 8:00 a.m. May 30 and trials 3, 4 and 5 made 2:00 - 4:00 p.m. May 30, 1938.

The data for sample "a" were obtained in the afternoon of May 29 between 1:00 and 5:00 p.m. Humidity was moderate and repeated blowings reduced the total weight, except for trial 7, in which case the seed stood on the table in open dishes for a half hour before the blowing was done. Inasmuch as most of the light weight seed was blown out within three or four minutes and the heavy seed subjected to the air blast for 17 minutes, it is believed that the greatest loss in moisture occurred in the heavy fraction. The percentages of heavy (pure) were uniform, indicating accuracy of separation. The data for sample "b" were obtained at different times. Trials 1 and 2 were made between 7:00 and 8:00 a.m., May 30 and trials 3, 4 and 5 were made between 2:00 and 4:00 p.m., May 30. Humidity was high in the early morning but by afternoon had lowered considerably. The uniformity was greater than for sample "a" since fewer light particles were involved.

In connection with the experiments dealing with the accuracy and uniformity of separation, it is interesting to refer to data obtained by Torpy, Sirrine, and Toole (8). In Table 5, of their publication, the percentages of purity resulting from the analysis of ten subsamples by the modified method as first suggested by Brown and Porter (4), except that the time of blowing ranged from one to ten minutes, as employed by Torpy, Sirrine, and Toole, were listed as 86.17, 89.10, 88.99, 87.85, 89.28, 87.82, 88.25, 87.40, 86.52 and 88.32, respectively. The present author calculated chi-square from the above data and obtained a value of 45.83 which gave a probability of .000004, thereby indicating that such aberrant results could not be expected from homogeneous subsamples when uniform methods of separation were employed. It is difficult to evaluate the data of Torpy, Sirrine, and Toole because the period of blowing was not uniform, however, the fact that a 5-minute period gave 3.11% higher purity than a one-minute period suggests that air pressure was not uniform at the 36-degree opening. The probable

lack in uniformity of air pressure is more certainly evident from the data in Table 2, page 99 (Torpy, Sirrine, and Toole) where the purities obtained by blowing the same sample 10 times for 10 minutes each were 64.30, 66.57, 66.96, 65.80, 65.10, 62.82, 65.89, 66.35, 64.46 and 65.55, respectively. The chi-square and probability values as determined by the present author using the above data are 30.45 and .000397, respectively. The differences are greater than among 64 different subsamples from the same lot when analyzed by a uniform method as shown on page 155 of the present paper.

Torpy, Sirrine, and Toole (8) in Tables 2 and 6 of their publication give the United States Department of Agriculture approximation of purity for two subsamples, each from a separate lot in which ten analyses were made on each subsample. In one case (Table 2) the difference between high and low is 0.82% and in the other (Table 6) 0.88%, both of which must be considered largely as human errors. Theoretically, there should be only small differences in purity in repeated analyses of the same subsample, but the important question to answer is: "How much of a difference is to be expected?"

The question can be answered in part by reference to Table 9 of this paper, in which the results of several analyses with each of two subsamples are shown, the average purities of which are similar to those in Tables 2 and 6 of Torpy, Sirrine, and Toole (8). For convenience of comparison, the data from the United States Department of Agriculture publication are shown with the Iowa data in Table 10.

TABLE 10.
COMPARISON OF SEPARATION BY IOWA AIR BLAST SEPARATOR AND APPROXIMATION--PERCENT PURE

Trials	Sample A Iowa	U.S.Dept.Agri. Approximation	Sample B Iowa	U.S.Dept.Agri. Approximation
1	69.57	70.62	88.66	88.71
2	69.54	70.43	88.71	88.43
3	69.25	70.90	88.68	88.96
4	69.20	70.08	88.77	88.94
5	69.32	70.78	88.64	88.08
6	69.22	70.55		88.36
7	69.46	70.80		88.25
8		70.12		88.94
9		70.25		88.93
10		70.35		88.78
Mean	69.37	70.50	88.69	88.64
Diff. in extremes	.37	.82	.13	.88
Average time in minutes	18	32	18	24

Statistical analysis of the data comparing the United States Department of Agriculture approximation and the Iowa method for the two lots of similar purities gave "F" values of 3.756 and 42.17 for the low and high purity samples, re-

spectively. Differences between the two laboratories, therefore, are not quite significant for the low but highly significant for the high purity samples. The greater difference in extremes as shown by the United States Department of Agriculture approximation than by the Iowa method may be concluded to be caused either by machine or human error.

The conclusion of Torpy, Sirrine, and Toole (8) is unfortunate in that they assumed their technique to be uniform at any given opening of the valve and attempted to show the undependability of the modified method as employed by them in making separation of heavy and inert material. Actually, their data illustrate strikingly the lack of uniformity in the method of analysis employed which was unquestionably caused by inconstancy of air pressure. Seed analysts should recognize that without uniform pressure it is impossible to use the modified method. One of the first factors which Brown and Porter (4) found necessary to control was variation in delivery of air due to inconstant speed of the fan. The latest seed separator unit in combination with a uniform speed motor and fan now installed in the Iowa Laboratory has been shown to maintain a constant pressure at any opening of the valve.

Referee tests by the Research Committee of the Association 1937-38 (3) showed that four out of six laboratories had equipment capable of making uniform separation of bluegrass.

Finally, it should be emphasized that fairly accurate and uniform separation of pure seed and inert material by the official method is possible for any one analyst working independently, but as applied by different laboratories the differences obtained are far too great for practical application.

Determination of Weight Per Bushel

The common practice among seed merchants until rather recent years, has been to trade in bluegrass on the basis of weight per bushel, which was considered to be an index of quality. Seed with a high test weight of 25 to 28 pounds was considered high purity seed, and, conversely, seed with a test weight of 10 to 15 pounds per bushel was considered low quality seed. Within certain limits, the bushel weight definitely indicates general quality, but seedsmen know that the weight per bushel is not completely reliable and that a rapid, accurate method of determining purity is much needed. The factors which have an important effect on purity are as follows:

1. The plumpness and maturity of the individual florets, which are dependent upon climatic factors. Immature, shriveled fruits are light in weight and their presence lowers the bushel weight without reducing the purity. In some seasons high purity lots give a low test weight and vice versa.

2. Multiple florets and spikelets are frequently empty or may contain one fertile floret. In either case the presence of a considerable amount of such material in bluegrass lowers the purity and also the weight per bushel.

3. Weed seeds and other crop seeds with a higher specific gravity than bluegrass seed, affect the purity inversely as they affect the bushel weight. Timothy, clover, sour dock, and sheep sorrel seeds increase the weight per bushel more than an equal volume of bluegrass seeds.

4. Portions of leaves of weeds and stems of bluegrass often have a weight per volume nearly equal to bluegrass seed. As high as 3% by weight of stems and leaves have been removed from the heavy portion after blowing at the upper limit of pressure for removal of infertile bluegrass florets.

5. Sand and grit when present, even in small quantities, have a marked effect on bushel weight and purity. Samples that contained sand and grit, whose bushel weight was above 24 pounds, have been tested and yet the purity was below 86%. Bluegrass with a test weight of 24 pounds and free from foreign material, other than bluegrass chaff, should show from 92 to 95% pure seed.

In spite of the above factors which affect both purity and weight per bushel, an experienced buyer can examine a lot of bluegrass, determine weight per bushel and make a reasonably accurate estimate of purity.

To obtain more information concerning the relationship of bushel weight and purity, as well as to provide an analyst with some guide as to the approximate purity of a sample, a small weight-per-bushel scale was purchased. The volume of the cup was found to be 140 millileters. All samples used in the experiments were tested for bushel weight, using three cupfuls and taking the average weight of the three. The procedure in the use of the scale was to pour seed into the cup until it would hold no more, then draw a straight edge gently back and forth across the top edge until the cup was level full of seed, after which it was placed on the scale and weight per bushel read directly.

The determination of weight per bushel for laboratory working samples was accomplished by the use of a five-milliliter cylinder graduated in tenths of a milliliter. The working sample was weighed, placed in a funnel with the thumb covering the bottom of the stem, and the seed allowed to flow slowly into the graduate which was then tapped gently on the table until no more settling occurred. Tapping is necessary because the height of the cylinder is several times its diameter, giving a disproportionate ratio of height and diameter to that of the scale cup. A cylinder with a small diameter is essential, otherwise small differences in volume cannot be determined.

To further aid in a rapid calculation of bushel weight in terms of volume in milliliters, a set of tabulations was prepared as shown in Table 11. The table shows weight of sample in milligrams from 400 to 1200 and volume in milliliters from two to four subdivisions of one-tenth. Interpolation is possible as between weights or volume.

As an illustration of the use of the table, assume that a sample of bluegrass was drawn with a weight of 900 milligrams, and a volume of 2.5 milliliters. The weight per bushel would be 24 pounds. Additional subsamples could be drawn and weight per bushel determined. Further illustrations are as follows: Assume that a seed sample weighs 5000 milligrams and has a volume of six milliliters. The table does not show bushel weights for either 5000 mg or 6 ml, but for 1000 mg and 3 ml the weight is 22.3. It is necessary, therefore, to multiply by 5 and divide by 2, which gives 55.8. Practically the same result may be obtained by referring to the value of 500 mg and 3 ml which is 11.1. It is necessary to multiply by 10 and divide by 2 or multiply by 5, giving 55.5 pounds per bushel.

It is believed that the use of the tables following some experience with the graduated cylinder will aid an analyst when samples received are too small to fill the scale cup. In addition, the determination of bushel weight of small working samples should aid in checking the accuracy of the divider or the representativeness of the sample drawn for analysis.

Following the preparation of the tables for determining weight per bushel, 10 samples were selected with a bushel weight ranging from 17.5 to 26.5 as determined by the small weight-per-bushel scale, duplicate working samples each weighing approximately one gram were drawn, weight per bushel of each determined and analysis completed according to the schedule on page 141. The data obtained

TABLE 11.
TABLE OF WEIGHTS PER BUSHEL WHEN VOLUME AND WEIGHT OF SAMPLE IN MILLIGRAMS ARE KNOWN.

Weight in Mg.	Volume of sample in milliliters									
	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
400	13.3	12.7	12.1	11.6	11.1	10.7	10.3	9.9	9.5	9.2
410	13.7	13.0	12.4	11.9	11.4	10.9	10.5	10.1	9.8	9.4
420	14.0	13.3	12.7	12.2	11.7	11.2	10.8	10.4	10.0	9.7
430	14.3	13.7	13.0	12.5	12.0	11.5	11.0	10.6	10.2	9.9
440	14.7	14.0	13.3	12.8	12.2	11.7	11.3	10.9	10.5	10.1
450	15.0	14.3	13.7	13.1	12.5	12.0	11.6	11.1	10.7	10.4
460	15.4	14.6	14.0	13.3	12.8	12.3	11.8	11.4	11.0	10.6
470	15.7	14.9	14.3	13.6	13.1	12.5	12.1	11.6	11.2	10.8
480	16.0	15.3	14.6	13.9	13.3	12.8	12.3	11.9	11.4	11.0
490	16.4	15.6	14.9	14.2	13.4	13.1	12.6	12.1	11.7	11.3
500	16.7	15.9	15.2	14.5	13.9	13.3	12.8	12.4	11.9	11.5
510	17.0	16.2	15.5	14.8	14.2	13.6	13.1	12.6	12.2	11.7
520	17.4	16.5	15.8	15.1	14.5	13.9	13.3	12.9	12.4	12.0
530	17.7	16.8	16.1	15.4	14.7	14.1	13.6	13.1	12.6	12.2
540	18.0	17.2	16.4	15.7	15.0	14.1	13.9	13.3	12.9	12.4
550	18.4	17.5	16.7	16.0	15.3	14.7	14.1	13.6	13.1	12.7
560	18.7	17.8	17.0	16.3	15.6	14.9	14.4	13.8	13.3	12.9
570	19.0	18.1	17.3	16.5	15.8	15.2	14.6	14.1	13.6	13.1
580	19.4	18.4	17.6	16.8	16.1	15.5	14.9	14.3	13.8	13.3
590	19.7	18.8	17.9	17.1	16.4	15.7	15.1	14.6	14.1	13.6
600	20.0	19.1	18.2	17.4	16.7	16.0	15.4	14.8	14.3	13.8
610	20.4	19.4	18.5	17.7	17.0	16.3	15.7	15.1	14.5	14.0
620	20.7	19.7	18.8	18.0	17.2	16.5	15.9	15.3	14.8	14.3
630	21.0	20.0	19.1	18.3	17.5	16.8	16.2	15.6	15.0	14.5
640	21.4	20.3	19.4	18.6	17.8	17.1	16.4	15.8	15.3	14.7
650	21.7	20.7	19.7	18.9	18.1	17.3	16.7	16.1	15.5	15.0
660	22.0	21.0	20.0	19.2	18.3	17.6	16.9	16.3	15.7	15.2
670	22.4	21.3	20.3	19.4	18.6	17.9	17.2	16.6	16.0	15.4
680	22.7	21.6	20.6	19.7	18.9	18.1	17.5	16.8	16.2	15.6
690	23.0	21.9	20.9	20.0	19.2	18.4	17.7	17.1	16.4	15.9
700	23.4	22.2	21.2	20.3	19.5	18.7	18.0	17.3	16.7	16.1
710	23.7	22.6	21.5	20.6	19.7	18.9	18.2	17.6	16.9	16.3
720	24.0	22.9	21.8	20.9	20.0	19.2	18.5	17.8	17.2	16.6
730	24.4	23.2	22.1	21.2	20.3	19.5	18.7	18.0	17.4	16.8
740	24.7	23.5	22.5	21.5	20.6	19.8	19.0	18.3	17.6	17.0
750	25.0	23.8	22.6	21.8	20.9	20.0	19.3	18.5	17.9	17.3
760	25.4	24.2	23.1	22.1	21.1	20.3	19.5	18.8	18.1	17.5
770	25.7	24.5	23.4	22.3	21.4	20.6	19.8	19.0	18.3	17.7
780	26.0	24.8	23.7	22.6	21.7	20.8	20.0	19.3	18.6	17.9
790	26.4	25.1	24.0	22.9	22.0	21.1	20.3	19.5	18.8	18.2

TABLE 11 (Cont.)
TABLE OF WEIGHTS PER BUSHEL

Weight in Mg.	Volume of sample in milliliters									
	2.1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
800	26.7	25.4	24.3	23.2	22.2	21.4	20.5	19.8	19.1	18.4
810	27.0	25.7	24.6	23.5	22.5	21.6	20.8	20.0	19.3	18.6
820	27.4	26.1	24.9	23.8	22.8	21.9	21.0	20.3	19.5	18.0
830	27.7	26.4	25.2	24.1	23.1	22.2	21.3	20.5	19.8	19.1
840	28.0	26.7	25.5	24.4	23.4	22.4	21.6	20.8	20.0	19.3
850	28.4	27.0	25.8	24.7	23.6	22.7	21.8	21.0	20.3	19.6
860	28.7	27.3	26.1	25.0	23.9	23.0	22.1	21.3	20.5	19.8
870	29.0	27.6	26.4	25.2	24.2	23.2	22.3	21.5	20.7	20.0
880	29.4	28.0	26.7	25.5	24.5	23.5	22.6	21.8	21.0	20.2
890	29.7	28.3	27.0	25.8	24.7	23.8	22.8	22.0	21.2	20.5
900	30.0	28.6	27.3	26.1	25.0	24.0	23.1	22.2	21.4	20.7
910	30.4	28.9	27.6	26.4	25.3	24.3	23.4	22.5	21.7	20.9
920	30.7	29.2	27.9	26.7	25.6	24.6	23.6	22.7	21.9	21.2
930	31.0	29.6	28.2	27.0	25.9	24.8	23.9	23.0	22.2	21.4
940	31.4	29.9	28.5	27.3	26.1	25.1	24.1	23.2	22.4	21.6
950	31.7	30.2	28.8	27.6	26.4	25.4	24.4	23.5	22.6	21.9
960	32.0	30.5	29.1	27.9	26.7	25.6	24.6	23.7	22.9	22.1
970	32.4	30.8	29.4	28.1	27.0	25.9	24.9	24.0	23.1	22.3
980	32.7	31.1	29.7	28.4	27.2	26.2	25.2	24.2	23.4	22.5
990	33.0	31.5	30.0	28.7	27.5	26.4	25.4	24.5	23.6	22.8
1000	33.4	31.8	30.3	29.0	27.8	26.7	25.7	24.7	23.8	23.0
1010	33.7	32.1	30.6	29.3	28.1	27.0	25.9	25.0	24.1	23.2
1020	34.1	32.4	30.9	29.6	28.4	27.2	26.2	25.2	24.3	23.5
1030	34.4	32.7	31.3	29.9	28.6	27.5	26.4	25.5	24.5	23.7
1040	34.7	33.1	31.6	30.2	28.9	27.8	26.7	25.7	24.8	23.9
1050	35.0	33.4	31.9	30.5	29.2	28.0	27.0	26.0	25.0	24.2
1060	35.4	33.7	32.2	30.8	29.5	28.3	27.2	26.2	25.3	24.4
1070	35.7	34.0	32.5	31.1	29.7	28.6	27.5	26.5	25.5	24.6
1080	36.0	34.3	32.8	31.3	30.0	28.8	27.7	26.7	25.7	24.9
1090	36.4	34.6	33.1	31.6	30.3	29.1	28.0	26.9	26.0	25.1
1100	36.7	35.0	33.4	31.9	30.6	29.4	28.2	27.2	26.2	25.3
1110	37.0	35.3	33.7	32.2	30.9	29.6	28.5	27.4	26.5	25.5
1120	37.4	35.6	34.0	32.5	31.1	29.9	28.8	27.7	26.7	25.8
1130	37.7	35.9	34.3	32.8	31.4	30.2	29.1	27.9	26.9	26.0
1140	38.0	36.2	34.6	33.1	31.7	30.4	29.3	28.2	27.2	26.2
1150	38.4	36.5	34.9	33.4	32.0	30.7	29.5	28.4	27.4	26.5
1160	38.7	36.9	35.2	33.7	32.2	31.0	29.8	28.7	27.6	26.7
1170	39.0	37.2	35.5	34.0	32.5	31.2	30.0	28.9	27.9	26.9
1180	39.4	37.5	35.8	34.2	32.8	31.5	30.3	29.2	28.1	27.2
1190	39.7	37.8	36.1	34.5	33.1	31.8	30.5	29.4	28.4	27.4
1200	40.0	38.1	36.4	34.8	33.4	32.0	30.8	29.7	28.6	27.6

TABLE 11 (Cont.)
TABLE OF WEIGHTS PER BUSHEL

Weight in Mg.	Volume of sample in milliliters										
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
400	8.9	8.6	8.3	8.1	7.9	7.6	7.4	7.2	7.0	6.8	6.7
410	9.1	8.8	8.6	8.3	8.0	7.8	7.6	7.4	7.2	7.0	6.8
420	9.3	9.0	8.8	8.5	8.2	8.0	7.8	7.6	7.4	7.2	7.0
430	9.6	9.3	9.0	8.7	8.4	8.2	8.0	7.8	7.6	7.4	7.2
440	9.8	9.5	9.2	8.9	8.6	8.4	8.2	7.9	7.7	7.5	7.3
450	10.0	9.7	9.4	9.1	8.8	8.6	8.3	8.1	7.9	7.7	7.5
460	10.2	9.9	9.6	9.3	9.0	8.8	8.5	8.3	8.1	7.9	7.7
470	10.5	10.1	9.8	9.5	9.2	9.0	8.7	8.5	8.3	8.0	7.8
480	10.7	10.3	10.0	9.7	9.4	9.2	8.9	8.7	8.4	8.2	8.0
490	10.9	10.5	10.2	9.9	9.6	9.3	9.1	8.8	8.6	8.4	8.2
500	11.1	10.8	10.4	10.1	9.8	9.5	9.3	9.0	8.8	8.6	8.3
510	11.3	11.0	10.6	10.3	10.0	9.7	9.5	9.2	9.0	8.7	8.5
520	11.6	11.2	10.8	10.5	10.2	9.9	9.6	9.4	9.1	8.9	8.7
530	11.8	11.4	11.1	10.7	10.4	10.1	9.8	9.6	9.3	9.1	8.8
540	12.0	11.6	11.3	10.9	10.6	10.3	10.0	9.7	9.5	9.2	9.0
550	12.2	11.8	11.5	11.1	10.8	10.5	10.2	9.9	9.7	9.4	9.2
560	12.5	12.1	11.7	11.3	11.0	10.7	10.4	10.1	9.8	9.6	9.3
570	12.7	12.3	11.9	11.5	11.2	10.9	10.6	10.3	10.0	9.8	9.5
580	12.9	12.5	12.1	11.7	11.4	11.1	10.8	10.5	10.2	9.9	9.7
590	13.1	12.7	12.3	11.9	11.6	11.3	10.9	10.6	10.3	10.1	9.8
600	13.4	12.9	12.5	12.1	11.8	11.4	11.1	10.8	10.5	10.3	10.0
610	13.6	13.1	12.7	12.3	12.0	11.6	11.3	11.0	10.7	10.4	10.2
620	13.8	13.3	12.9	12.5	12.2	11.8	11.5	11.2	10.9	10.6	10.3
630	14.0	13.6	13.1	12.7	12.4	12.0	11.7	11.4	11.1	10.8	10.5
640	14.2	13.8	13.4	12.9	12.6	12.2	11.9	11.5	11.2	11.0	10.7
650	14.5	14.0	13.6	13.1	12.8	12.4	12.1	11.7	11.4	11.1	10.8
660	14.7	14.2	13.8	13.3	13.0	12.6	12.2	11.9	11.6	11.3	11.0
670	14.9	14.4	14.0	13.5	13.2	12.8	12.4	12.1	11.8	11.5	11.2
680	15.1	14.6	14.2	13.7	13.3	13.0	12.6	12.3	11.9	11.6	11.3
690	15.4	14.9	14.4	14.0	13.5	13.2	12.8	12.4	12.1	11.8	11.5
700	15.6	15.1	14.6	14.2	13.7	13.3	13.0	12.6	12.3	12.0	11.7
710	15.8	15.3	14.8	14.4	13.9	13.5	13.2	12.8	12.5	12.1	11.8
720	16.0	15.5	15.0	14.6	14.1	13.7	13.3	13.0	12.6	12.3	12.0
730	16.2	15.7	15.2	14.8	14.3	13.9	13.5	13.2	12.8	12.5	12.2
740	16.5	15.9	15.4	15.0	14.5	14.1	13.7	13.3	13.0	12.7	12.3
750	16.7	16.1	15.6	15.2	14.7	14.3	13.9	13.5	13.2	12.8	12.5
760	16.9	16.4	15.9	15.4	14.9	14.5	14.1	13.7	13.3	13.0	12.7
770	17.1	16.6	16.1	15.6	15.1	14.7	14.3	13.9	13.5	13.2	12.8
780	17.4	16.8	16.3	15.8	15.3	14.9	14.5	14.1	13.7	13.3	13.0
790	17.6	17.0	16.5	16.0	15.5	15.1	14.6	14.3	13.9	13.5	13.2

TABLE 11 (Cont.)
TABLE OF WEIGHTS PER BUSHEL

Weight in Mg.	Volume of sample in milliliters										
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
800	17.8	17.2	16.7	16.2	15.7	15.3	14.8	14.4	14.0	13.7	13.3
810	18.0	17.4	16.9	16.4	15.9	15.4	15.0	14.6	14.2	13.9	13.5
820	18.2	17.7	17.1	16.6	16.1	15.6	15.2	14.8	14.4	14.0	13.7
830	18.5	17.9	17.3	16.8	16.3	15.8	15.4	15.0	14.6	14.2	13.8
840	18.7	18.1	17.5	17.0	16.5	16.0	15.6	15.2	14.8	14.4	14.0
850	18.9	18.3	17.7	17.2	16.7	16.2	15.8	15.3	14.9	14.5	14.2
860	19.1	18.5	17.9	17.4	16.9	16.4	15.9	15.5	15.1	14.7	14.3
870	19.4	18.7	18.1	17.6	17.1	16.6	16.1	15.7	15.3	14.9	14.5
880	19.6	18.9	18.4	17.8	17.3	16.8	16.3	15.9	15.5	15.1	14.7
890	19.8	19.2	18.6	18.0	17.5	17.0	16.5	16.1	15.6	15.2	14.8
900	20.0	19.4	18.8	18.2	17.7	17.2	16.7	16.2	15.8	15.4	15.0
910	20.2	19.6	19.0	18.4	17.9	17.4	16.9	16.4	16.0	15.6	15.2
920	20.5	19.8	19.2	18.6	18.1	17.5	17.1	16.6	16.2	15.7	15.3
930	20.7	20.0	19.4	18.8	18.3	17.7	17.2	16.8	16.3	15.9	15.5
940	20.9	20.2	19.6	19.0	18.5	17.9	17.4	17.0	16.5	16.1	15.7
950	21.1	20.5	19.8	19.2	18.6	18.1	17.6	17.1	16.7	16.3	15.8
960	21.4	20.7	20.0	19.4	18.8	18.3	17.8	17.3	16.9	16.4	16.0
970	21.6	20.9	20.2	19.6	19.0	18.5	18.0	17.5	17.0	16.6	16.2
980	21.8	21.1	20.4	19.8	19.2	18.7	18.2	17.7	17.2	16.8	16.3
990	22.0	21.3	20.7	20.0	19.4	18.9	18.4	17.9	17.4	16.9	16.5
1000	22.3	21.5	20.9	20.2	19.6	19.1	18.5	18.0	17.6	17.1	16.7
1010	22.5	21.7	21.1	20.5	19.8	19.3	18.7½	18.2	17.7	17.3	16.8
1020	22.7	22.0	21.3	20.7	20.0	19.5	18.9	18.4	17.9	17.5	17.0
1030	22.9	22.2	21.5	20.9	20.2	19.6	19.1	18.6	18.1	17.6	17.2
1040	23.1	22.4	21.7	21.1	20.4	19.8	19.3	18.8	18.3	17.8	17.3
1050	23.4	22.6	21.9	21.3	20.6	20.0	19.5	18.9	18.4	18.0	17.5
1060	23.6	22.8	22.1	21.5	20.8	20.2	19.7	19.1	18.6	18.1	17.7
1070	23.8	23.0	22.3	21.7	21.0	20.4	19.8	19.3	18.8	18.3	17.8
1080	24.0	23.3	22.5	21.9	21.2	20.6	20.0	19.5	19.0	18.5	18.0
1090	24.3	23.5	22.7	22.1	21.4	20.8	20.2	19.7	19.1	18.6	18.2
1100	24.5	23.7	22.9	22.4	21.6	21.0	20.4	19.8	19.3	18.8	18.3
1110	24.7	23.9	23.2	22.6	21.8	21.2	20.6	20.0	19.5	19.0	18.5
1120	24.9	24.1	23.4	22.8	22.0	21.4	20.8	20.2	19.7	19.2	18.7
1130	25.1	24.3	23.6	23.0	22.2	21.5	21.0	20.4	19.8	19.3	18.8
1140	25.4	24.5	23.8	23.2	22.4	21.7	21.1	20.6	20.0	19.5	19.0
1150	25.6	24.8	24.0	23.4	22.6	21.9	21.3	20.7	20.2	19.7	19.2
1160	25.8	25.0	24.2	23.6	22.8	22.1	21.5	20.9	20.4	19.8	19.3
1170	26.0	25.2	24.4	23.8	23.0	22.3	21.7	21.1	20.5	20.0	19.5
1180	26.3	25.4	24.6	24.0	23.2	22.5	21.9	21.3	20.7	20.2	19.7
1190	26.5	25.6	24.8	24.2	23.4	22.7	22.0	21.5	20.9	20.4	19.8
1200	26.7	25.8	25.0	24.4	23.6	22.9	22.2	21.6	21.1	20.5	20.0

are shown in Table 12, with incomplete tabulations for sample No. 4 which is the result of an oversight.

TABLE 12.
BLUEGRASS ANALYSES IN DUPLICATE, SHOWING A COMPARISON OF BUSHEL WEIGHTS FROM BULK AND WORKING SAMPLES IN RELATION TO PURITY.
IOWA AIR BLAST SEPARATOR

Sample No.	Wt. per bu.	Bu. Wt. Working Sample	Mean weight	Percentages by weight				Mean purity	Diff. in pairs
				Pure Seed	Crop Seed	Inert Matter	Weeds Seeds		
1 a	17.5	17.0	17.1	81.03		18.51	.46	82.23	2.41
b		17.2		83.44		15.73	.83		
2 a	19.0	19.2	18.95	77.67	--	21.97	.36	76.81	1.72
b		18.7		75.95	--	23.48	.57		
3 a	19.5	18.9	18.85	82.45	--	17.31	.24	81.75	1.40
b		18.8		81.05	--	18.59	.36		
4 a	20.0	--	--	82.39	--	15.54	2.07	82.85	.92
b		--		83.31	--	15.31	1.38		
5 a	20.5	20.5	20.6	82.88	--	16.58	.54	83.25	.75
b		20.7		83.63	--	16.17	.20		
6 a	20.5	20.4	20.25	85.36	--	14.21	.43	85.74	.77
b		20.1		86.13	--	13.59	.28		
7 a	21.5	20.9	20.8	82.10	.29	17.32	.29	82.05	.10
b		20.7		82.0	.29	17.52	.19		
8 a	21.5	21.7	21.4	87.37	--	12.54	.09	87.21	.31
b		21.1		87.06		12.84	.10		
9 a	22.5	21.8	21.6	89.92		9.82	.96	89.90	.03
b		21.4		89.89		9.77	.34		
10 a	26.5	25.4	25.55	97.13	--	2.78	.09	96.93	.39
b		25.7		96.74	.10	3.06	.10		

The differences in paired samples are not significant in any case, indicating uniformity of each pair of subsamples as drawn. An important observation, however, is that the weight per bushel is not well correlated with the purity; for example, sample No. 1 has the lowest weight per bushel, but shows a purity significantly higher than samples No. 3 and 7. Sample No. 7 is equal in bushel weight to sample No. 8 and greater than sample No. 6, yet in purity it is significantly less that either sample No. 6 or 8. The reasons for this apparent disparity are to be found in the duscussion above of the factors affecting weight per bushel.

A final conclusion is that the bushel weight of the working samples as determined was usually less than that of the bulk sample, but probably not significantly so, hence, the method as developed for small working samples gives a result which agrees reasonably well with the bushel weight of the bulk sample. The use of the method to measure the accuracy of the divider will be discussed in the next section.

Study of Samples Delivered by The Boerner Sampler

Referee tests in Region No. 2 (3), using redtop and orchard grass seed, sug-

gested that the divider did not deliver uniform subsamples. To test the divider for bluegrass, 64 grams of seed were drawn from a lot whose bushel weight was 22.5 pounds. The sample was then subdivided into 64 subsamples by the Boerner sampler in such a manner that the number of times a given subsample was passed through each side was recorded. For example, after the first division, the half from spout "b" of the divider was set aside and the portion from spout "a" was subdivided, the half from spout "b" again being held for later subdivision. When the divisions were all completed one subsample out of 64 had passed through only spout "a", one only through spout "b" and the balance included all possible combinations, such as once through the spout "b" and five times through spout "a" (No. 2). Each subsample passed through the divider six times and the number of times through each spout is shown in the figure.

Following the subdivisions each sample was analyzed, using a slight modification of the schedule on page 141 because of differences in weight of sample. The modification was such that at the final blowing period the opening of the dial was no higher than 20.8, but the preceding openings were made according to pressure.

The percentage pure, weight of working sample for 64 subsamples and number of normal sprouts obtained from the inert material of 32 subsamples are shown in Table 13. The chi-square value as determined for the respective percentages of purity was 84.77 and the standard normal deviate was found to be 1.75, indicating no significant differences. The difference in extremes is seen to be 2.37%, hence the divider appears to deliver subsamples which are reasonably uniform in purity. The number of normal sprouts from the 32 inert fractions is fairly uniform, in fact the maximum number is 45, which would be equal to about

Figure 2. A seed mixer made in the College Instrument Shop and used in the Iowa State College Seed Laboratory for mixing samples of orchard grass and bluegrass prior to passage through the Boerner divider. The container rotates at an angle on the same principle as a cement mixer.

TABLE 13
VARIATION IN PURITIES OF 64 SUBSAMPLES OF BLUEGRASS SEED DRAWN BY THE BOERNER SAMPLER AND TESTED BY A UNIFORM METHOD

Sample No.	Drawn from initial half through spout "a"			Sprouts, inert	Sample No.	Drawn from initial half through spout "b"			Sprouts, inert
	Weight bushel	Weight sample	Pure seed			Weight bushel	Weight sample	Pure seed	
	Pounds	grams	%			Pounds	grams	%	
1	22.1	.857	87.9	45	33	22.5	.909	87.6	16
2	21.9	.908	87.8		34	22.4	.977	89.3	
3	22.2	.900	88.9	21	35	22.5	.958	89.0	18
4	22.2	.932	89.0		36	22.3	.997	88.0	
5	22.5	.900	89.2	15	37	22.3	.957	88.0	22
6	22.3	.934	88.8		38	22.5	1.007	88.3	
7	22.4	.939	88.9	41	39	22.3	.999	89.1	36
8	22.4	.973	88.1		40	22.4	1.046	88.1	
9	22.2	.904	88.6	28	41	22.5	.957	87.9	25
10	22.3	.929	88.2		42	22.5	.990	88.9	
11	22.3	.940	89.4	27	43	22.5	1.016	89.1	34
12	22.3	1.008	88.4		44	22.4	1.041	89.1	
13	21.8	.940	88.6	24	45	22.4	1.018	88.6	17
14	22.2	.998	88.7		46	22.3	1.070	88.6	
15	22.3	.976	89.0	27	47	22.4	1.058	87.9	32
16	22.3	1.035	88.4		48	22.5	1.107	88.6	
17	22.4	.927	87.3	35	49	22.5	.944	87.7	31
18	22.5	.983	89.0		50	22.4	1.020	88.5	
19	22.5	.964	88.6	19	51	22.5	1.013	89.0	24
20	22.3	1.012	88.4		52	22.5	1.044	88.8	
21	22.3	.951	89.6	30	53	22.4	1.009	88.9	28
22	22.2	1.014	87.6		54	22.4	1.096	89.4	
23	22.0	1.010	89.1	20	55	22.3	1.078	89.5	12
24	22.6	1.052	88.5		56	22.4	1.120	89.7	
25	22.0	.937	87.7	35	57	22.3	.981	88.7	28
26	22.4	.976	89.1		58	22.4	1.042	88.7	
27	22.4	.994	88.5	16	59	22.4	1.052	88.6	15
28	22.4	1.046	88.6		60	22.4	1.111	89.4	
29	22.5	.976	88.8	29	61	22.5	1.060	89.3	24
30	22.2	1.040	88.6		62	22.7	1.121	88.4	
31	22.2	1.033	88.7	22	63	22.7	1.110	88.4	35
32	22.6	1.090	89.0		64	22.6	1.146	88.9	
Mean	22.29	.9713	88.6			22.4	1.033	88.7	

Mean purity of all samples - 88.64%.

0.6 % change in purity and the smallest number is 12, which would mean about 0.2% change in purity. Furthermore, nearly half the sprouts developed after 15 days, indicating slow germination and less value as seed than those in the heavy fractions.

The final total weight of all the 64 subsamples was 64.136 grams, but 32

subsamples weighed less than one gram and 32 more than one gram.

Some significance may be attached to the fact that subsample No. 1 which was obtained by passage only through spout "a" was the lightest of all subsamples, whereas subsample 64 which was obtained by passage only through spout "b" was the heaviest of all the samples, and the mean weight of the two was 1.0015. The mean weight of all the 64 subsamples was 1.0021. The mean purity of the two subsamples No. 1 and No. 64 was 88.39, which was not far from the mean purity of all the subsamples.

Further study of the weight of samples as given in Table 13 was made by grouping the samples into 7 classes as follows:

Class No.	Number times passed through	
	Spout a	Spout b
1	6	0
2	5	1
3	4	2
4	3	3
5	2	4
6	1	5
7	0	6

The sample number and weight of sample are given in Table 14 by classes together with the mean weight of each class. The uniformity of weight within a class is rather striking in all the classes and especially so in classes 2 and 6. In class 3 all subsamples were heavier than in class 2 and only one was heavier than any in class 4. In class 4, 10 subsamples weighed less than one gram and 10 others more than one gram. Furthermore, no subsample in class 4 was equal to the weight of any one in class 5 and the mean weight of all 20 subsamples in class 4 was 0.9993 grams, which is 2.8 milligrams less than the mean weight of any subsample in class 6. The data conclusively show that although the divider does not separate equally by weight, yet the separation for the bluegrass sample used was consistant for each spout and the purity of all subsamples was reasonably uniform.

A further observation which may be worthy of note is that the mean purity of samples 33 to 64 inclusive was greater than that of samples No. 1 to 32 inclusive, which may be correlated with the slightly higher mean bushel weight of the working samples.

Application of Techniques to Laboratory Practice

In the preceding experiments, data have been presented which give rather conclusive evidence that when samples vary in weight above or below one gram, the most reliable and uniform separation is obtained by dependence on the dial reading as a measure of uniform volume of air delivered by the fan. When a series of subsamples are drawn from a lot, the divider does not deliver samples of uniform weight, hence if a uniform method of analysis is to be used to study natural variability, dependence should be placed on dial readings rather than on the manometric pressure in the compression chamber.

The data further show that if samples of similar weight be drawn from a given lot (Table 2) the difference in purity of the replicates is not significant when

TABLE 14

CLASSIFICATION AND WEIGHT IN GRAMS OF 64 SUBSAMPLES OF BLUEGRASS SEED AS DIVIDED BY THE BOERNER SAMPLER

Class 1		Class 2		Class 3		Class 4		Class 5		Class 6		Class 7	
Sample	Wt.	Sample	Wt.	Sample	Wt.	Sample	Wt.	Sample	Wt.	Sample	Wt.	Sample	Wt.
1	.857	2	.908	4	.932	8	.973	16	1.035	32	1.090	64	1.146
		3	.900	6	.934	12	1.008	24	1.052	48	1.107		
		5	.900	7	.939	14	.998	28	1.046	56	1.120		
		9	.904	10	.929	15	.976	30	1.040	60	1.111		
		17	.927	11	.940	20	1.012	31	1.033	62	1.121		
		33	.909	13	.940	22	1.014	40	1.046	63	1.110		
				18	.983	23	1.010	44	1.041				
				19	.964	26	.976	46	1.070				
				21	.951	27	.994	47	1.058				
				25	.937	29	.976	52	1.044				
				34	.977	36	.977	54	1.096				
				35	.958	38	1.007	55	1.078				
				37	.957	39	.999	58	1.042				
				41	.957	42	.990	59	1.052				
				49	.944	43	1.016	61	1.060				
						45	1.018						
						50	1.020						
						51	1.013						
						53	1.009						
						57	.981						
Mean	.857		.908		.9495		.9993		1.053		1.1098	1.146	

uniform procedure, based on pressure as measured by the manometer connected to the pressure chamber, is used. Inasmuch as most seed laboratories generally use approximately one gram of bluegrass seed for a working sample, it was decided that one gram would be taken as the basic weight in regular routine practice, but that all samples would be obtained by subdivision to nearly one gram rather than to add to or subtract from a subsample until exactly one gram was obtained.

Following the first experiments with the manometer it was soon discovered that although a given schedule of blowing was followed for all samples with similar weights, yet some variation occurred in the number of fertile florets removed from samples differing in weight per bushel. Inasmuch as no regular service sample of bluegrass is similar to a synthetic sample in that many gradations occur between the extremely heavy and light florets, recognition was given to the necessity of developing an arbitrary, empirical method as opposed to the method based on the possibility of absolute purity. For example, the maximum pressure for accurately separating a one-gram synthetic sample is 18 millimeters on the diagonal scale, or a dial opening of 21, yet 18 mm. is above the maximum pressure for the separation of most service samples into fertile and infertile florets. The pressure of 18 mm. is sufficient to remove many immature, light weight, viable florets. The viability of questionable florets is generally lower than of the mature ones, hence if too many are retained in the pure seed, they adversely affect the percentage of germination, and if they are removed, the purity is reduced. Practically, it is necessary to either arbitrarily adopt a uniform procedure, or test the inert fraction for normal sprouts and make a correction in purity based on number of normal sprouts obtained.

To study the effect of uniform procedure, 14 service samples were selected and two working samples were drawn for analysis. The blowing schedule was the same as on page 141, which provides for an increase in the duration of time at 8.5 mm. as measured by the vertical manometer, or at 17.0 mm. as measured by the diagonal one. The data obtained are given in Table 15 and include bushel weight of bulk sample, initial purity, number of sprouts in the inert fraction, corrected purity, germination, and index value. The method of germination was the one described in a previous paper, (6), namely, on sterile sand in petri dishes.

With the exception of samples No. 7a and 7b, the number of sprouts obtained in the inert fraction is reasonably uniform for each pair and the difference in purity between members of each pair is not significant, indicating uniformity of technique. The number of normal sprouts obtained from the inert fractions was not high enough to reduce the purity by much more than 1% as a maximum and 0.4% on the average, yet it seemed desirable to devise a means of reducing the number removed to a lower figure. The method decided upon was to reduce the maximum pressure to 16 mm. (diagonal scale) and use the major portion of the blowing period at 14 and 15 millimeters to permit the removal of all the light weight material before applying the maximum pressure. The schedule used was as follows:

Minutes	Millimeters
1	10.0
1	12.0
8	14.0
8	15.0
3	15.5
2	16.0

TABLE 15.
INITIAL PURITIES, GERMINATION NORMAL SPROUTS IN INERT FRACTION AND CORRECTED PURITIES OF BLUEGRASS-IOWA AIR BLAST SEPARATOR, 1938.

Sample No.	Weight per bushel	Initial purity	Sprouts inert	Corrected purity	Mean purity corrected	Germination	Index P x G
	lbs.	%		%	%	%	
1 a	20.5	85.6	37	86.1	86.7	77	66.6
b		86.8	26	87.2			
2 a	22.5	89.7	8	89.8	89.7	77	68.1
b		89.5	11	89.6			
3 a	21.5	86.6	4	86.6	86.5	76	65.6
b		86.3	3	86.3			
4 a	20.0	82.0	21	82.3	82.8	79	65.5
b		83.0	17	83.2			
5 a	24.0	89.2	9	89.4	89.3	82	73.4
b		89.2	10	89.3			
6 a	22.3	83.9	34	84.4	84.3	81	68.5
b		83.6	44	84.2			
7 a	22.0	88.7	10	88.9	89.3	88	78.1
b		89.4	29	89.8			
8 a	20.8	85.1	39	85.7	86.3	88	75.5
b		86.5	30	86.9			
9 a	21.0	87.5	89	88.8	88.6	92	81.4
b		87.3	79	88.4			
10 a	20.6	87.3	17	87.6	87.6	74	64.7
b		87.4	15	87.6			
11 a	19.5	82.2	45	82.9	83.1	92	76.6
b		82.7	45	83.4			
12 a	20.5	83.9	13	84.2	84.1	81	67.7
b		83.7	23	84.0			
13 a	20.5	86.6	13	86.8	86.7	73	63.3
b		86.3	20	86.6			
14 a	20.5	85.0	63	85.9	85.6	90	77.2
b		84.7	48	85.4			

Note: Bluegrass with 85% purity and 85% germination has index value of 72.25.

The heavy seed was examined each time and multiple florets and spikelets in which no fertile floret was present were removed, together with all other types of foreign material, but no single florets were removed. The fractions removed at 15.5 and 16 mm. of pressure were saved separately and examined for fertile seed, but the amounts removed were so small that they were considered of little importance. In one instance 32 such florets that were considered as having each a caryopsis weighed three milligrams which is half the normal weight of fertile florets and their location in the inert fraction would have reduced the purity only 0.32%. In practice, it seems unnecessary to examine the fractions removed at the 15.5 and 16 mm. pressures, as all may be considered as inert.

The above method requires from 10 to 20 minutes per sample in addition to the period required for blowing. Since analytical work may be done while most

of the blowing is being accomplished, it is possible to complete an average of two analyses per hour.

To check the operation of the separator against the judgement of analysts, several pure seed fractions were sent to official and commercial analysts for examination. In most cases the amount of inert material removed was insignificant in its effect either on purity or germination.

A further check was made by analyzing samples, recombining the fractions, and submitting identical samples to other analysts or by sending the several fractions in separate containers for examination. No disagreement was encountered when the several fractions were submitted separately for examination, but when recombinations were submitted for analysis some difference of opinion was manifested.

Study of Samples from Seedsmen

In February, 1938, a sample of bluegrass seed was submitted for analysis on which a purity of 85.02% was obtained. The company stated that two other analyses of 88.44 and 90.7% had been reported. The company was requested to draw a working sample, complete the analysis, recombine the fractions and return to Iowa Laboratory together with another one-fourth pound sample from the same lot. The purity of the recombined sample was determined as 86.07% by the Iowa Laboratory and 86.49% by the company. The difference between the original report of 85.02% and the two tests with an identical sample is not significant and could be expected from a uniform lot of seed.

From the second one-fourth pound sample submitted, a subsample was drawn and analyzed with a resultant purity of 88.83%. The fractions were sent to the company for examination and only insignificant materials were removed from the pure seed fraction.

The results of the above comparative tests and checks indicated that the two bulk samples submitted for analysis were not uniformly representative inasmuch as the difference between purity percentages of 85.02 and 88.83 is highly significant.

One further experience deserves brief discussion. Three small lots representing carlot shipments were obtained from a seed house. Analyses were made and compared with reports from a commercial analyst. In two cases the Iowa tests were significantly lower. A request was then made for additional samples and the seedsman sent an eight-pound bulk sample from each of two lots. One working sample was drawn from each eight-pound lot and analyzed as were the previous ones. The data obtained are presented in Table 16.

TABLE 16
COMPARATIVE PURITIES OF BLUEGRASS SEED USING SMALL AND LARGE BULK LOTS.

Lot	Pure seed		
	Commercial analyst	Iowa Laboratory	
		Small sample	Eight-pound sample
	%	%	%
a	86.89	81.37	85.10
b	85.45	84.79	- -
c	86.55	83.07	85.00

The conclusion that seems justifiable from Table 16 is that two of the small samples first submitted to the Iowa Laboratory were not truly representative of each lot, at least for lot "a" and possibly also for lot "c".

To study the method of bulking, mixing, and sampling in a seed house a visit was made to one that handles large quantities of bluegrass seed. The seedsman decided to make up a 25-bag lot of 22-pound seed with a purity of about 85%. Twenty-five bags were tested for bushel weight and 13 were placed at one end of the room and 12 at the other. Two men dumped one sack at a time by spreading the contents of a bag starting at one end and walking to the other, then returning with a sack obtained from the end where they had completed dumping the first bag. When all 25 bags were dumped, the seed was shoveled over 3 or 4 times from one end to the other, after which bushel weight was taken from each end and in the middle. Samples were drawn and analyzed with the results as given in Table 17. The mean weight being nearly 22-3/4 pounds, the contents of 3 more bags with a lower quality of seed were added to the long pile and mixed by shoveling.

Samples were drawn from the middle and at each end by thoroughly stirring the seed in a given area with the hands, then drawing a weighing cupful from which bushel weight was determined. A portion of each cupful was placed in a separate envelope, the balance mixed together as a bulk sample. A second bulk sample was then obtained by 16 hand grabs starting from the east and extending to the west end of the pile. After the seed was bagged, a sample was drawn from each of five bags, two from each end and one at the center. The ten samples thus obtained were analyzed by the uniform method, the results of which are given in Table 17.

The data in Table 17 are worthy of study and careful analysis. Samples S28, S29 and S30 were drawn from east, center and west sections of the pile before any light weight material was added. The sample from the east end gave the lowest purity, which was probably significantly lower than the purity of the sample drawn from the center. Samples S31, S32 and S33 were drawn from the same sections respectively but after light weight material was added. The purity of sample S31, which was from the east end, is significantly lower than the purities of samples S32 and S33. There is a strong indication that an unequal distribution of the light weight material was made, the larger portion being distributed at the east end. Samples S26 and S27 represent two methods of attempting to draw a representative bulk lot, and so far as the data are concerned either method is equally reliable. Samples S34 to S38, inclusive, were drawn from five bags respectively, two from the east half, two from the west half, and one from the center after the mixed seed had been bagged.

Unfortunately, the samples were not properly designated as to the section from which they were drawn but the indications are that samples S36 and S37 were from the east half. The average of the three samples S31, S32, and S33 which is about 1% higher than the average of the five samples S34 to S38, inclusive, may be caused by the fact that in the former group the sample from the east end represents one-third of the group, while in the latter the two low purity samples represent two-fifths of the group. The variations in purity among the samples from the five bags strongly indicate improper bulking and any buyer who should receive bags represented by samples S36 and S37 would claim that the purity was too low, however, the purity of S37 is not significantly lower than a purity of 85.

TABLE 17
PURITIES OF SAMPLES DRAWN BY DIFFERENT METHODS AND FROM DIFFERENT SECTIONS OF A 25-BAG BULK LOT OF BLUEGRASS SEED.

Sample No.	How drawn	Bushel weight bulk sample	Bushel weight working sample	Weight working sample	Pure Seed	Average pure seed
		lbs.	lbs.	grams	%	%
S 26	Bulk sample from east and west ends and center	22.5	21.3	1.021	84.9	
S 27	Bulk sample 16 hand grabs	22.0	21.5	1.021	84.8	
S 28	East end before adding light	22.5	21.5	1.036	86.0	
S 29	Center before adding light	23.5	22.5	1.001	88.4	87.1
S 30	West end before adding light	22.5	21.7	.998	87.0	
S 31	East end pile after adding light	22.0	20.8	1.063	83.2	
S 32	Center after adding light	22.5	21.2	1.014	86.1	85.0
S 33	West end after adding light	22.25	21.6	1.032	85.8	
S 34	Bag 1 after sacking	22.0	21.0	1.038	84.9	
S 35	Bag 2 after sacking	22.0	21.0	1.004	84.8	
S 36	Bag 3 after sacking	21.75	20.3	1.033	82.2	84.1
S 37	Bag 4 after sacking	21.75	20.9	.910	83.4	
S 38	Bag 5 after sacking	22.0	21.1	.871	85.1	

Recommended Procedure for Analysis of Bluegrass

In other sections of this paper (Tables 2, 10, and 12) it has been shown that if approximately one gram of a synthesized sample containing only the extremes of heavy and light florets be used, a maximum manometer reading of 18 mm. (9mm. on the vertical scale) will remove practically all the empty florets. Naturally, the empty florets are removed most rapidly at the maximum pressure used, however, repeated trials have shown that if the total time of blowing is materially reduced, it is necessary to use a longer portion of the time at the upper limit which may remove some heavy florets, particularly if the pressure in the tube is not uniformly distributed from the center to the walls.

Inasmuch as commercial samples of seed contain some florets which are not so sharply divided as those in the synthetic samples, it was soon discovered that most samples should not be subjected to the maximum pressure used for synthetic samples, rather the upper limit had to be lowered and the major portion of the period of blowing applied at pressures below the upper limit. The reason for this modification lies in the fact that many light weight viable florets in certain samples are readily removed at a pressure insufficient to remove heavy plump seed.

As was shown previously (6) the light weight, immature and shriveled caryopses are the ones which are most difficult to classify when the official method of procedure is used and as long as human judgment is variable, differences of greater than expected magnitude will occur unless an empirical, arbitrary method of procedure is adopted. The writer is of the opinion that the preferable procedure is to remove a few of the viable florets rather than to leave empty ones in the heavy portion, and if necessary make a purity correction of 0.1% for every seven seedlings obtained from the inert fraction.

The most satisfactory schedule for blowing samples when using the Iowa air blast separator and fan as described in this paper is as follows:

Time in minutes	Manometer readings (inclined tube)
1	12.0
1	14.0
8	15.0
3	16.0
2	16.5
2	17.0

Samples with a bushel weight below 15 pounds should have the period at 16 mm. increased to five minutes and also be blown two additional minutes at 18 mm. for the maximum pressure. If the above schedule be followed with representative samples, each weighing approximately one gram, uniform results will be obtained with the result that uniform pure seed fractions for germination will be used, which practice should eliminate some of the extreme differences in germination of bluegrass seed.

The detailed procedure which is recommended as a result of all the experiments conducted since 1933 is as follows:

1. Determine weight per bushel of the bulk sample as received by the laboratory.

2. Divide the bulk sample into two parts by the divider and then subdivide the portion from spout "a" until approximately one gram which has passed only through spout "a" is obtained. Follow the same procedure with the initial portion from spout "b" except that the final one-gram sample should have passed only through spout "b".

3. Analyze either the two one-gram samples separately or mix together and subdivide until nearly one gram is obtained.

4. Weigh the sample, determine its volume and from Table 11 calculate bushel weight in pounds. If the weight is more than one pound less than that of the bulk sample, draw another one for analysis as described above.

5. Place the sample in the base of the separator cup and subject it to the blowing schedule above.

6. Remove from the heavy fraction all foreign material including seeds and in addition any multiple florets or spikelets which contain no caryopses. Check the sample for other species of Poa.

7. Place the inert fraction in the germinator and if desired add 0.1% to the purity for each seven normal seedlings which appear.

Recommendation No. 7 is made only as a possible procedure in case the ideal of absolute purity be strictly adhered to. The rules of the Association of Official Seed Analysts require that in making tests of any kind of seed, all seeds, half seeds or less be placed in the inert fraction. Some of such broken seeds are viable, hence an error is introduced in determining the seeding value. The error involved in the removal of a few fertile bluegrass seeds by the proposed modified method is probably no greater than that in attempting to classify broken seeds. If the procedure is uniform and gives a figure close to absolute purity, it should assist in measuring the quality of seed lots. Inasmuch as some empty florets are attached to fertile ones and are not removed in the modified method, it is believed that the removal of a few fertile florets compensates for the empty attached ones retained with the pure seed which have no effect on germination.

Both seedsmen and analysts should recognize that the adoption of a uniform, empirical method as is proposed will not solve all the difficulties encountered in the labeling of bluegrass. Of equal importance are uniform methods of germination and proper bulking, mixing, and sampling of the seed. Samples should be drawn as accurately as possible from well mixed lots, and separations made by a divider into the number of samples it is deemed necessary to submit for analysis. Weight per bushel should be determined and recorded on the container so that an analyst can compare such with that determined in the laboratory.

An important precaution for the adoption by any laboratory of the techniques herein outlined is that the manometer readings are based on the delivery of air by a standard motor and fan operating at a fairly uniform number of revolutions per minute with a sample approximately one gram in weight. If any other fan or source of air pressure be used or if the weight of the sample is less then 0.950 or more than 1.050 grams, a different schedule for the use of the air blast separator will need to be determined.

Tests with Orchard Grass

To investigate the variability among subsamples of orchard grass seed obtained by subdivisions in the Boerner sampler, approximately 64 grams were drawn from a bulk lot whose purity had been found to be about 77%. The 64-gram portion

was first mixed in a new mixer, illustrated in Figure 3, then subdivided into 32 subsamples by the procedure described for bluegrass. Each of 18 subsamples was then weighed and analyzed by the modified method of procedure described by Seiferle and Porter (7) except that pressure was used as the criterion, rather than the dial reading, and the schedule was as follows:

Time	Manometer reading (vertical tube)
1	11.0
1	12.0
5	13.0
1	13.5

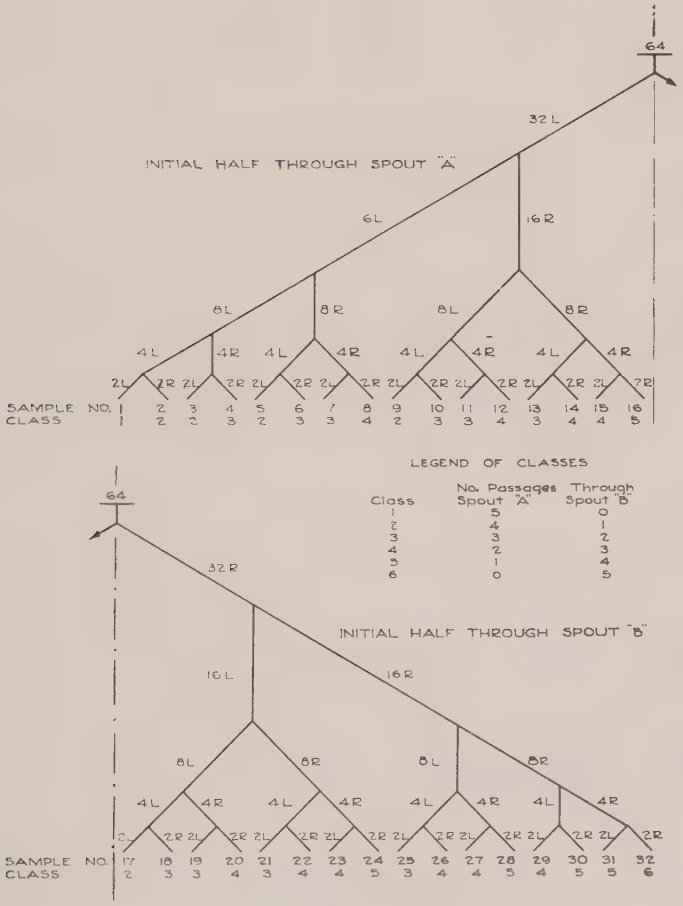
64
32 L
INITIAL HALF THROUGH SPOUT "A"
16 R
8 L
8 R
4 L
4 R
2 L
2 R
SAMPLE NO. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
CLASS 1 2 2 3 2 3 3 4 2 3 3 4 3 4 4 5
LEGEND OF CLASSES
Class
No. Passages Through Spout "A"
Spout "B"
1 5 0
2 4 1
3 3 2
4 2 3
5 1 4
6 0 5
64
32 R
INITIAL HALF THROUGH SPOUT "B"
16 L
16 R
8 L
8 R
4 L
4 R
2 L
2 R
SAMPLE NO. 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
CLASS 2 3 3 4 3 4 4 5 3 4 4 5 4 5 5 6

Figure 3 - Diagrammatic scheme showing the method by which 32 subsamples of orchard grass seed were obtained by the Boerner sampler.

The other 14 samples, numbers 19 to 32, were analyzed by the modified method in which the dial reading was taken as the criterion using the following schedule:

Time	Dial reading
1	20.0
1	21.0
5	22.0
1	22.5

The weight of each sample, percent pure, number of sprouts obtained from each fraction, and the percentage germination obtained from the pure seed fractions of eight subsamples are all shown in Table 18.

The uniformity of purity for the first 18 subsamples may be considered satisfactory in that the probability was found to be 0.44, yet the uniformity of the last 14 subsamples is too pronounced. One point worthy of note is that the number of sprouts obtained from the inert fractions was less when the dial reading in place of pressure was used as the basis of separation. If pressure be used as the criterion for separation the weight of sample should be nearly two grams. Uniformity of germination from the pure seed fraction of eight subsamples is shown in Table 18. The probability value was found to be 0.70, indicating uniformity of pure seed fractions and uniformity of technique in making the tests.

A classification of the subsamples of orchard grass by the method used for bluegrass gave similar results. Figure 4 illustrates the manner in which the several subsamples were obtained and shows the class to which each sub-sample belongs. Table 19 shows the classification and weight of each sample. The total weight of all samples was 61.722 grams, mean weight was 1.929 and the mean of classes 1 and 6 was 2.080, which is slightly more than would be expected. Uniform division of orchard grass in so far as weight is concerned is apparently more difficult than with bluegrass.

Tests with Redtop

The uniformity obtained in making purity analyses of bluegrass and orchard grass seed with the air blast separator led to trials with redtop seed. The problem of uniform purity tests of redtop is different than with the two other grasses, in that redtop has no multiple florets, yet empty and smutted spikelets are common and are not easily detected.

To test the efficiency of the separator, four subsamples of redtop seed, each weighing about 500 milligrams, were drawn and treated in a uniform manner in the separator by using the following schedule:

Time Minutes	Manometer reading (vertical scale) mm.
1	3.00
1	4.00
3	4.75
5	5.25
3	6.00

TABLE 18
SUMMARY OF ANALYSIS OF 32 SUBSAMPLES OF ORCHARD GRASS BY MODIFIED METHOD

Pressure in vertical manometer used as basis				Dial reading used as basis				
Sample No.	Weight sample	Pure seed	Number sprouts inert	Sample No.	Weight sample	Pure seed	Number sprouts inert	Germination 14 days
	grams	%			grams	%		%
1	1.735	77.3	24	19	1.927	77.9	3	83
2	1.774	77.6	20	20	1.911	76.8	8	81
3	1.726	77.3	10	21	1.829	76.8	4	
4	1.910	77.7	9	22	1.956	77.2	1	78
5	1.838	79.2	5	23	1.956	78.5	6	
6	1.809	76.5	12	24	2.151	76.9	7	79
7	1.893	77.5	11	25	1.853	77.1	8	
8	1.987	76.0	10	26	1.983	77.8	4	79
9	1.778	78.0	11	27	1.924	77.2	2	
10	1.868	76.6	15	28	2.015	77.9	2	78
11	1.911	76.9	12	29	1.975	77.6	5	
12	2.064	76.9	6	30	2.061	77.8	8	78
13	1.891	76.4	10	31	2.125	77.7	4	
14	1.978	75.7	13	32	2.226	76.7	1	80
15	1.988	77.0	13					
16	1.998	75.50	14					
17	1.822	77.2	13					
18	1.860	77.5	13					
Mean	1.879	77.1	12.3		1.992	77.4	4.5	79.5
χ^2		17.25				4.83		4.60
P		.44				.97		.70

All material which came over with up to 4.75 mm. pressure was emptied separately and examined. No redtop seeds were present, but many yarrow seeds were found. At pressures of 5.25 and 6.00 mm., a trace of redtop was removed. The hand work with the heavy fraction consisted of removing a few ergotized grains, some inert material, other crop seeds, and weed seeds.

The results of the detailed analyses are given in Table 20. The probability value for the four purities was found to be 0.14, indicating reasonably uniform results.

To further test the separator as well as the divider, approximately 16 grams of redtop seed were drawn from a sample whose purity was about 92%. The sample was next divided into 32 subsamples in the manner described for the orchard grass seed. Analyses were made, using the same method as for the subsamples in Table 20. The data obtained with the 32 subsamples are given in Table 21 in which the weight of sample in grams, percent pure and mean percent germination of 400 seeds taken from the pure seed fractions of eight subsamples are recorded.

The percentages of purity obtained from 32 subsamples were uniform, in so far as the probability test is concerned, and the difference in extremes (1,34) is less than allowed by the tolerance formula of the Association of Official Seed

TABLE 19
CLASSIFICATION AND WEIGHT IN GRAMS OF 32 SUBSAMPLES OF ORCHARD GRASS SEED AS DIVIDED BY BOERNER SAMPLER

Class 1		Class 2		Class 3		Class 4		Class 5		Class 6	
Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight
1	1.735	2	1.774	4	1.910	8	1.987	16	1.998	32	2.226
		3	1.726	6	1.809	12	2.064	24	2.151		
		5	1.838	7	1.893	14	1.978	28	2.015		
		9	1.778	10	1.868	15	1.988	30	2.061		
		17	1.822	11	1.911	20	1.911	31	2.125		
				13	1.891	22	1.956				
				18	1.860	23	1.956				
				19	1.927	26	1.983				
				21	1.829	27	1.924				
				25	1.853	29	1.975				
Mean	1.735		1.768		1.8751		1.9722		2.070		2.226

TABLE 20
UNIFORM ANALYSES OF REDTOP SEED, USING THE IOWA AIR BLAST SEPARATOR.

Subsample	Original Weight	Final Weight	Pure Seed	Crop Seed	Weed Seed	Inert
	gms.	gms.	%	%	%	%
a	.517	.513	86.2	0.78	9.8	3.3
b	.525	.522	86.8	1.15	9.0	3.1
c	.537	.540	86.5	0.74	9.6	3.2
d	.508	.509	87.0	0.98	9.4	2.6
Mean	.522		86.61			
X^2			5.64			
P			.14			

Analysts, which has been recommended, when twice as large a sample is used. The germination of the pure seed fractions from eight subsamples was also strikingly uniform, thus further indicating that when half-gram samples of redtop seed are analyzed by a modified method, the variation is less than that allowed for one-gram samples by the Association of Official Seed Analysts rules.

The classification and weight of the 32 subsamples are given in Table 22. The sampler divides redtop in the same manner as bluegrass in that the weight within each class is reasonably uniform but the divisions are not equal. The heaviest subsample passed only through spout "b" but the subsample which passed only through spout "a" lacked three milligrams of being the lightest weight sample. It may be concluded that the Boerner sampler divides unequally in weight but uniformly within classes, based on the number of passages through each spout, and uniformly as to purity.

TABLE 21
SUMMARY OF ANALYSES OF 32 SUBSAMPLES OF REDTOP SEED BY THE MODIFIED METHOD

Sample No.	Weight sample	Pure seed	Germination	Sample No.	Weight sample	Pure Seed	Germination
	gms.	%	%		gms.	%	%
1	.468	92.4	93	17	.485	91.9	93
2	.476	91.4		18	.507	92.4	
3	.494	92.0		19	.498	92.3	
4	.517	92.3		20	.525	92.4	
5	.484	91.4	94	21	.501	91.8	95
6	.501	92.4		22	.518	91.9	
7	.512	91.7		23	.520	92.1	
8	.535	91.7		24	.545	92.1	
9	.465	91.1	93	25	.490	91.3	91
10	.495	92.5		26	.525	92.2	
11	.500	92.1		27	.510	92.1	93
12	.524	92.2		28	.541	92.3	
13	.496	91.9	93	29	.520	92.4	
14	.521	92.4		30	.556	92.1	
15	.517	91.8		31	.541	92.3	
16	.537	91.9		32	.569	92.2	
Mean of all	.512	92.0	93				
X^2		32.175	5.298				
P		.39	.52				

CONCLUSIONS

The data presented and discussed in this paper justify the following conclusions:

1. Analysis of synthetic samples of bluegrass seed by means of uniform pressure as developed and maintained by a constant speed motor and fan in conjunction with the Iowa air blast separator gives accurate and uniform separation of light weight infertile florets from pure seed.

2. The method of procedure for the analysis of bluegrass seed as used and described herein is applicable to laboratory practice for the determination of purity of commercial samples. The uniformity obtained by the method proposed gives results well within the range of natural variability and is much greater than when the official method of analysis is employed.

3. A uniform method for the determination of pure seed in bluegrass samples provides uniform pure seed fractions which eliminates one of the variable factors that has long contributed to extreme variations in germination tests.

4. The method proposed, if adopted by seedsmen, should make it possible to check quickly and accurately methods of bulking and uniformity of the seed in bags of a lot offered for sale.

5. A slight modification of the method described for purity analyses of bluegrass is applicable to tests with seed of orchard grass and redtop and gives

TABLE 22
CLASSIFICATION AND WEIGHT IN GRAMS OF 32 SUBSAMPLES OF REDTOP SEED AS DIVIDED BY BOERNER SAMPLER

Class 1		Class 2		Class 3		Class 4		Class 5		Class 6	
Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight	Sample	Weight
1	.468	2	.476	4	.517	8	.535	16	.537	32	.549
		3	.494	6	.501	12	.524	24	.545		
		5	.484	7	.512	14	.521	28	.541		
		9	.465	10	.498	15	.517	30	.556		
		17	.485	11	.500	20	.525	31	.541		
				13	.496	22	.518				
				18	.507	23	.520				
				19	.498	26	.525				
				21	.501	27	.510				
				25	.490	29	.520				
Mean	.468		.481		.502		.522		.545		.549

equally uniform results.

6. The Boerner sampler divides seed of bluegrass, orchard grass, and redtop unequally as to weight but uniformly and consistently for each spout. The purity of subsamples delivered by the Boerner sampler is uniform and well within the range of natural variability.

7. A method has been developed and a set of tables prepared by which the bushel weight in pounds of small working samples of bluegrass and other seeds can be determined.

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FARM DEMONSTRATIONS AS A MEASURE OF SEED VIABILITY IN ALFALFA, RED CLOVER AND SWEET CLOVER[1]

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The interpretation of seed laboratory tests of crop seeds as a measure of field value has been attempted by several investigators in Europe and North America. In Iowa, Erickson and Porter[2] compared laboratory and field germination of soybeans, sorghum, red clover, sweet clover, and alfalfa. Laboratory tests of the alfalfa and clovers were found to be indicative of the relative value of each lot in the field. Field germination was seldom more than half that in the laboratory but samples which tested high or low in the laboratory generally maintained a relative position in the field trials. The tests referred to were made on the Agricultural Experiment Station plots at Ames, Iowa.

To further compare laboratory and field tests as well as to investigate the effect of soil and climate in different localities of the state on field stands of alfalfa and clovers, a series of field tests was initiated in 1936 and continued through the 1938 seeding season.

Samples of seed were obtained from the State Department of Agriculture and were remnants of lots sampled by the State Seed Inspectors. All samples were tested in the College Seed Laboratory for both purity and viability. Similar tests had been made by the State Department and the purity and germination as stated on the label by the vendor were also made available by State Inspectors.

The seed samples used in field plantings were obtained by weighing each on a chainomatic balance with four replicates from each lot for each plot. In 1936 the plantings were made in rows 16 feet long and one foot apart. The quadruplicate sub-samples were planted side by side with flax as a nurse crop (9 grams of flax per 16-foot row). The flax and legume seeds for each row were thoroughly mixed together and scattered as uniformly as possible in the row using 3, 2, and 3 grams per row of alfalfa, red clover, and sweet clover, respectively. Because of an error in calculation, the rate of seeding was about three times too heavy, however, it was uniform throughout each plot. Plantings were made in three localities and counts were made about one month after seeding by determining the total number of legume plants in a three-foot length near the middle portion of each row.

In 1937 and 1938 the method of sowing was modified. Instead of using rows 16 feet long and counting only the seedlings in a uniform part of it, five-foot rows were used and all the seedlings were counted. Consequently, the rate of seeding was cut down from 3 grams per 16-foot row to 1/3 gram per five-foot row. Furthermore, one seeding was made at a normal rate, 0.3333 gram per row and another seeding at half a normal rate, or 0.1666 gram per row. Each sample was then represented by two different rates of seeding in each plot. Since all seedlings were counted in 1937 and 1938, it was believed to be a more exact study of

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[1] Contribution from the Iowa Agricultural Extension Service. Published with the approval of the director.

[2] Erickson, E. L. and Porter, R. H., Laboratory Tests of Field Crop Seeds as an Index of Seeding Value. Iowa Agr. Exp. Sta. Res. Bul. 239. 1938.

the germinating power of the seeds. Laboratory purity and germination were again recorded and compared as in 1936.

Plantings were made in six localities in 1937 and in five to 1938. The data obtained are shown in Tables 1, 2, and 3 for the seasons of 1936, 1937, and 1938, respectively. Each table gives the purity and germination test for each sample as determined by the vendor, the State Department and the College Seed Laboratory. In addition, the approximate number of pure seeds per given area based on the College Laboratory purity test and the average number of plants from an equal area in each locality obtained from each sample are shown.

Summary

The data obtained in this paper were collected within a period of three crop seasons, one of which was marked by excessive drouth. Weather conditions during the other two seasons were more nearly normal. The plots were located in different sections of the state and on different types of soil. It is believed that the data obtained under such variable environmental conditions, together with differences in rates of seeding, are of value in that they indicate some of the problems involved in obtaining satisfactory stands of small-seeded legumes. The more important points may be summarized as follows:

1. The number of plants produced by the same amount of seed from similar subsamples was extremely variable in different plots for each year thus emphasizing the effect of locality on seed germination. By reference to the totals for each crop in three plots (Table 1) it may be noted that the germination in plot 2 was lower except for red clover. Similar results were obtained in 1937 and 1938, although the response in a given location was not always consistent for each kind of seed or for each lot of a given kind of seed.

2. In most cases the samples that gave the higher germination in the laboratory (College) produced the higher germination in the field, although differences in quality of the lots of a given kind were not great enough to expect wide differences in the field, except in the 1937 and 1938 plots.

3. The total number of plants from each lot for all plots was definitely dependent on the rate of seeding, in that seedings made at half the normal rate produced approximately half the number of plants that were obtained where the normal rate was used.

4. The number of plants per square foot produced by a lot was obtained by dividing the total number in each plot by the number of square feet represented. The number thus obtained was variable and apparently was dependent on seed quality and environment. The average number of plants in plots sown at the rate of 7½ pounds per acre varied from as low as 2.5 (sweet clover sample 2, Table 3) to as high as 11.1 (red clover sample 3, Table 2) plants per square foot.

5. The purity percentages reported by the vendor and the two seed laboratories for each lot agreed well, with but few exceptions. Differences in germination and in percentage of hard seeds were greater than should be expected for a small percentage of the samples, although the number of samples which could be considered as mislabeled was small.

TABLE 1
COMPARISON OF LABORATORY AND FIELD GERMINATION OF ALFALFA, RED CLOVER, AND SWEET CLOVER - IOWA, 1936.

Kind and sample No.	Pure seed % (1)	Laboratory			Field			
		Percentage germination (2)			Number plants per 3 sq. feet by plots (3)			Total Plants
		Vendor	State Department	College Lab.	1	2	3	9 sq. ft.
Alfalfa								
1	99.1	77-16	84-10	86-9	150	127	140	417
2	99.5	96-	92-3	90-4	149	62	110	321
3	98.2	85-9	81-6	80-9	176	89	132	397
4	98.5	84-7	79-7	81-4	158	59	113	330
5	99.2	84-12	88-6	89-6	149	129	139	417
6	99.7	93-	92-4	91-7	141	135	133	409
7	99.9	96-	93-5	94-3	143	139	133	415
8	99.7	95-12	95-5	93-6	161	43	129	333
9	98.6	80-12	94-2	92-7	144	44	101	289
10	99.7	71-19	89-7	91-3	150	77	113	340
Red Clover								
1	97.3	87-8	84-6	85-4	120	171	135	426
2	99.0	78-20	81-9	79-11	111	197	153	461
3	95.2	82-8	81-6	79-7	78	44	68	190
4	96.9	87-8	91-2	86-4	106	101	101	308
5	98.8	88-8	92-1	86-3	93	108	100	301
6	99.9	97-	98-1	97-1	148	213	141	502
7	95.4	81-12	76-7	70-26	77	93	81	251
8	99.6	98-1	95-2	97-1	101	84	87	272
9	92.9	92-6	94-3	89-3	102	60	76	238
10	94.4	96-1	92-4	91-2	103	135	120	358
Sweet Clover								
1	98.6	89-1			163	105	130	398
2	98.7	93-6	78-14	83-7	128	69	99	296
3	97.0	82-8	88-2	83-7	170	154	151	475
4(4)	96.8	81-9	91-6	93-4	210	132	175	517
5	99.8	95-	93-2	91-2	169	116	111	396
6	99.6	93-6	99-1	98-1	305	154	203	662
7(4)	83.3	94-2	81-4	80-	180	43	129	352
8	99.7	93-2	91-6	94-5	158	109	85	352
9(4)	95.3	94-	66-11	48-45	107	77	103	287

(1) College Laboratory analysis.
(2) 77-16, means 77% germination and 16% hard seeds.
(3) Approximate numbers of seeds per 3 sq. feet were as follows: alfalfa, 280; red clover, 213 to 220, except No. 9 which was 208; and sweet clover, 310 to 319, except No. 7 which was 267 and No.9 which was 305.
(4) There was fairly good agreement between the percentages of purity of all sample in this table except for sweet clover as follows: No. 4 - Vendor, 99.1; State Department 95.3; and College Laboratory, 96.8. No. 7 - Vendor, 98.4; State Department, 85.7; and College Laboratory, 83.3 No. 9 - Vendor 99.3; State Department, 96.8; and college Laboratory, 95.3.

TABLE 2

COMPARISON OF LABORATORY AND FIELD GERMINATION OF ALFALFA, RED CLOVER, AND SWEET CLOVER - IOWA, 1937.

Kind and sample No.	Pure seed % (1)	Laboratory Percentage Germination(2) Vendor	State Department	College Lab.	Field Number plants per 5 sq. feet by plots (3)	1	2	3	4	5	6	Total Plants 30 sq. feet
Alfalfa					a	44	79	21	35	37	50	266
1	97.2	83-10	67-11	72-11	b	18	41	18	14	28	24	142
					a	58	95	41	46	78	65	384
2	99.7	88-8	87-9	85-9	b	13	56	28	18	42	34	192
					a	40	99	40	48	73	65	363
3	99.6	95-	93-4	83-5	b	17	44	25	16	47	26	173
					a	37	107	39	40	56	72	352
4	99.5	95-	78-13	81-10	b	13	56	36	15	44	28	194
					a	32	90	38	43	49	55	307
5	99.4	84-6	78-4	79-5	b	10	53	36	17	30	31	176
					a	57	116	52	53	84	61	423
6	99.9	85-10	85-10	88-5	b	18	57	42	18	27	42	203
					a	21	62	21	18	43	31	194
7	92.3	54-9	51-8	47-14	b	14	29	21	8	14	15	99
					a	40	111	42	36	63	67	358
8	99.8	94-	85-9	84-8	b	19	47	33	18	28	37	182
9					a	64	107	63	44	57	86	420
Nontreated	99.7	85-10		79-13	b	24	58	42	13	29	40	207
9					a	43	100	52	59	63	60	376
Treated	99.7	85-10		79-13	b	25	49	43	13	31	47	208
Red Clover					a	95	139	71	112	121	107	644
1	97.9	96-	95-4	96-3	b	42	74	53	38	65	45	317
					a	38	79	33	50	60	46	306
2	92.8	96-	56-4	51-9	b	19	40	28	14	30	18	148
					a	102	148	86	89	134	112	671
3	99.9	99-	88-10	86-13	b	46	75	52	45	73	45	335
					a	80	133	85	82	116	102	597
4	98.7	69-25	71-25	75-21	b	44	72	46	46	49	36	293
5					a	80	122	70	74	123	95	563
Nontreated	99.7	96-		74-24	b	30	63	36	42	59	47	277
5					a	66	115	81	70	107	94	532
Treated	99.7	96-		74-24	b	44	63	44	28	60	46	284
Sweet Clover					a	29	68	48	55	92	70	360
1	97.9	90-	60-4	67-4	b	32	31	26	20	46	32	187
					a	29	67	38	45	76	60	315
2	99.5	93-5	72-1	65-13	b	30	37	27	16	36	35	180
					a	46	68	41	50	85	62	351
3	99.2	86-10	73-10	77-9	b	22	47	24	14	42	28	178
					a	44	93	56	69	90	73	426
4	99.8	88-9	67-15	75-20	b	43	45	27	20	50	36	221
					a	35	85	52	52	76	55	355
5	99.8	88-9	75-20	73-20	b	33	51	19	20	44	27	194

(1) College Laboratory analysis.
(2) 83-10, means 83% germination and 10% hard seeds.
(3) Normal rate of 15 pounds per acre equaled approximate number of seeds per 5 square feet as follows: alfalfa, 162 to 167, except No. 7 which was 154; red clover, 196 to 199, except No.2 which was 185; and sweet clover, 188 to 190, except No. 1 which was 186. a - normal rate, b - half normal rate.

TABLE 3
COMPARISON OF LABORATORY AND FIELD GERMINATION OF ALFALFA, RED CLOVER, AND SWEET CLOVER - IOWA, 1938.

Kind and sample No.	Pure seed % (1)	Laboratory Percentage Germination(2) Vendor	State Department	College Lab.	Field Number plants per 5 sq. feet by plots (3) 1	2	3	4	5	Total Plants 25 sq. feet
Alfalfa					a 52	40	72	53	39	256
1	99.2	92-	68-8	77-13	b 29	12	32	22	17	112
					a 62	7	76	64	41	250
2	98.9	85-9	64-28	61-32	b 32	15	35	29	20	131
					a 58	10	52	49	24	193
3	88.1	86-6	66-8	70-14	b 36	24	17	25	11	113
					a 67	6	65	58	31	227
4	99.6	95-	70-24	79-16	b 38	10	28	30	20	126
					a 49	1	55	57	42	204
5	98.9	98-	73-23	65-28	b 33	27	17	30	10	117
					a 49	1	63	45	39	197
6	99.6	97-	48-47	54-39	b 30	12	26	20	18	106
					a 57	1	66	54	50	228
7	99.6	96-	68-29	69-26	b 24	8	33	27	15	107
					a 61	1	79	50	53	244
8	96.3	94-	86-3	67-28	b 34	2	28	25	9	98
					a 41	1	85	59	66	252
9	96.7	94-	63-31	69-24	b 23	24	20	31	17	115
					a 35	6	65	51	35	192
10	97.7	91-	77-	80-14	b 29	14	14	16	5	78
Red Clover					a 48	13	100	79	95	335
1	97.4	93-	72-13	87-10	b 38	13	24	25	24	124
					a 63	102	87	71	91	414
2	97.1	91-	92-3	92-2	b 46	3	23	26	25	123
					a 81	42	133	93	116	465
3	98.9	95-	89-9	92-8	b 45	4	58	43	33	183
					a 62	7	76	61	78	284
4	99.4	73-23	68-28	71-28	b 36	9	18	27	22	112
					a 48	32	98	83	102	365
5	99.0	96-	97-	97-2	b 40	1	28	46	31	146
Sweet Clover					a 32	32	38	35	39	176
1	98.8	94-	72-8	81-7	b 25	0	11	20	6	62
					a 34	35	61	38	64	232
2	97.5	92-	56-37	64-34	b 24	0	12	24	7	67
					a 52	47	47	42	46	234
3	99.4	90-3	79-8	73-10	b 28	0	8	27	6	69
					a 45	34	32	30	46	187
4	99.3	87-	81-	87-2	b 20	0	11	28	10	69
					a 59	38	35	69	57	258
5	98.9	97-	87-	81-10	b 38	0	13	30	11	92
					a 64	53	77	57	83	334
6	99.8	93-	91-	86-9	b 31	0	18	39	17	105

(1) College Laboratory analysis.
(2) 68-8, means 68% germination and 8% hard seeds.
(3) Normal rate of 15 pounds per acre equaled approximate number of seeds per 5 square feet as follows: alfalfa, 161 to 167, except No. 3 which was 149; red clover, 194 to 199; and sweet clover, 185 to 189, except No. 6 which was 170. a - normal rate, b - half normal rate.

FURTHER STUDIES ON THE DISTRIBUTION OF WEED SEEDS IN, AND OF RESULTS OF GERMINATION TESTS ON REPLICATE SAMPLES.

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Studies on Red Clover and Timothy

In continuation of a study of certain statistical aspects of seed testing, large bulks (20-30 lbs.) of timothy and red clover were carefully mixed with weighed quantities of the seeds of pigweed (Amaranthus retroflexus) and small seeded false flax (Camelina microcarpa) and divided down to samples of three to four ounces. These samples were then distributed among the seven Canadian laboratories functioning at that time with the request to conduct certain specified tests on them. The writer would like to express his appreciation of the careful and complete cooperation accorded by each laboratory, which was so vital to the success of this series of experiments. Totals of 472 purity analyses and 448 germination tests were made on the lot of red clover and 816 and 814 respectively on the timothy.

Purity Analyses

Each laboratory analyzed 4 x 1/4 oz. from each sample of timothy and 4 x ½ oz. from each of red clover. The results were summarized so as to show the number of analyses in which 0, 1, 2, etc., weed seeds were found by each laboratory separately and by all laboratories together (thus arranged as distributions) for each kind of weed seed separately.

Now, it has been shown that results of analyses conducted in this manner follow the Poisson distribution under ordinary circumstances when the seed has been properly mixed and if, on applying the chi-square test for goodness of fit, we find that the observed results follow the expected Poisson distribution closely, we are justified in concluding that the bulk has been properly mixed.

If they do not give a good fit, then we have two possible alternatives:-

(1) We may conclude that the samples were not satisfactory and that the seed was not properly mixed.

(2) We may suspect that the weed seed in question will not bulk properly, no matter how thorough the mixing. In this case conditions may justify a deeper search for the law governing the distribution, which if found will throw much light on the problem.

It should be stressed that the Poisson values exhibit the least possible variation that can be expected with the best possible bulking and sampling.

Results

Small Seeded False Flax in Red Clover and Timothy

Without giving the results in detail, it may be stated that the values of P secured ranged from 0.02 to 0.95 (the next low value to 0.02 being 0.28) indicating excellent concordance with expectation and showing that bulking and

sampling had been satisfactory. There was a little more irregularity in the red clover than in the timothy, the mean numbers of small seeded false flax per half ounce in the former ranging from 1.64 in one laboratory to 2.77 in another. This, due to some rather high values contributed by the latter laboratory, resulted in a somewhat low value for P (< 0.01) when all laboratories were taken together, but on the whole there is evident no significant departure from the Poisson distribution. In the case of the timothy, the value of P for all laboratories was 0.53, which was so good that P values for individual laboratories were not calculated.

The mean rate for all laboratories was 2.32 per half ounce of red clover, with results ranging from 0 to 8, and 1.30 per fourth ounce of timothy, the results ranging from 0 to 6.

Pigweed in Red Clover and Timothy

The results for pigweed, however, present a very different situation. In Tables 1 and 2 are given the results for red clover and timothy respectively, for all laboratories. The Poisson distribution for the mean rate of 44.4 per half-ounce does not remotely resemble the observed results which show a far greater scatter than would be expected. The range is from 12 to 114, whereas in the Poisson theory we would expect the range to be about from 24 - 64. We must now go back to the two alternatives mentioned before. The writer has chosen the second, feeling that a deeper search was justified since it has already been shown that when the components of a mixture of seeds differ markedly in size, a peculiar behavior is observed.

This part of the subject is somewhat difficult but an attempt will be made to make it as clear as possible.

It appears that the smaller of the two kinds, under certain circumstances behaves as though it were grouping itself in little clusters about equal in size to the average size of a seed of the larger element in the mixture. This clustering tendency seems to be referable to the following factors:-

(1) A considerable disparity in size between the two kinds.

(2) A surface smooth enough to let the smaller seeds "slip together".

(3) The relative volumes occupied by unit numbers of the two kinds of seeds (Unit Volumes).

(4) Possibly the shapes of the two kinds of seed.

(1) and (2) appear to be related somewhat as follows:
Provided that the surface of the smaller is smooth enough there need not be such a great disparity between the sizes of the two kinds to make the effect operative. If, however, the surface is rough or tends to be sticky, or at least not slippery, a considerable disparity in size may exist without the effect being operative.

With these ideas in mind, we may ask ourselves the question, "How may these factors be brought into a scheme which will permit us to predict, with given kinds of seeds, the limits of the variation to be expected?"

In a previous paper the writer has shown that this can be done by treating the clusters as units themselves and determining the expected distribution of the clusters.

In the present case we have ideal conditions for testing this hypothesis since the surface of the pigweed is very smooth and there exists a great disparity between the size of the pigweed and that of the red clover. Not only that

TABLE 1.
DISTRIBUTION OF PIGWEED IN RED CLOVER. ANALYSIS RESULTS FROM 472 HALF-OUNCE REPLICATES.

Number of Pigweed Seeds Found		Number of Analyses					
		36	16	61	5	96	2
12	1	37	14	62	6		
13	1	38	13	63	9		
14		39	16	64	2	101	1
15	1	40	15	65	4		
16		41	14	66	3	105	1
17	2	42	10	67	4		
18	3	43	11	68	2		
19	1	44	18	69	1		
20	4	45	19	70	5		
21	1	46	13	71	2	114	1
22	5	47	8	72	2		
23	3	48	8	73	4		
24	6	49	10	74		Total	472
25	6	50	13	75	1		
26	8	51	9	76	2		
27	6	52	10	77			
28	4	53	6	78			
29	8	54	10	79	1		
30	10	55	4				
31	6	56	8	84	1		
32	12	57	11	85			
33	16	58	8	86	1		
34	14	59	8	87	2		
35	14	60	6				

Mean rate = 44.4 Pigweed per half-ounce

but, for theoretical reasons into which we need not enter, the test can be made much better for a Poisson distribution than for a binomial distribution as was attempted in the work referred to above.

The mean cluster size is determined as follows:-

The cluster size is the "unit number" of the impurity divided by the "unit number" of the crop seed. This unit number is a relative number and is simply the bushel weight divided by the 1000 kernel weight, which gives the number of kernels in a unit volume.

In the case of pigweed in red clover, the mean cluster size is 4.975, and thus the mean number of clusters per half-ounce corresponding to the observed mean number of seeds; viz., 44.4 per half-ounce, is:-

$$\frac{44.4}{4.975} = 8.93 \text{ clusters per half-ounce}$$

Using this value as the mean number of clusters and calculating the Poisson distribution for this mean, we arrive at the "cluster distribution". When this was compared with the observed distribution, grouped for clusters, the result was

$$X^2 = 13.17$$
$$n = 12$$
$$P = .37$$

This value of P indicates that our observed results, properly grouped for clusters, give an excellent fit with expectation, fully supporting the hypothesis. Thus the sample cannot have been improperly mixed (with respect to pigweed - we know it was properly mixed with respect to false flax) as would be held under the first of the two alternatives but, when properly mixed it exhibits these peculiar features and the expected variability can be calculated from the known relevant relationships between the two kinds of seeds.

For the purposes of prediction, it is convenient to use the standard deviation, since the percentages of cases included within plus or minus the standard deviation, twice the standard deviation and so on, are known.

The standard deviation for clusters must be converted to a form applicable to seeds - a form which the writer called the "Adjusted S. D. for seeds".

The adjusted standard deviation for seeds under the cluster hypothesis is given by:-

$$\text{Adjusted } \sigma_{(\text{Seeds})} = c\left(\sigma \frac{m}{c}\right)$$

where c is the mean cluster size
and m is the mean number of seeds.

In the present case c = 5 very nearly and m = 44.4 which gives

$$\text{Adjusted } \sigma_{(\text{Seeds})} = 14.9$$

Since $\pm 3\sigma$ covers practically all the expected variation, this gives us a total range of 6 x 14.9, i.e. approximately 90. Actually the observed range was 102 but note that only two cases out of 472 exceed the 90 range.

Thus the statistical behaviour of the two kinds of seeds may be determined simply from a knowledge of their bushel and 1000 kernel weights. Table 2 presents similarly the results for pigweed in timothy.

Here, again, a precisely similar situation exists and again the cluster hypothesis provides the clue to the amount of variation that may be expected. The necessary calculations were carried out and gave: -

$$X^2 = 17.5$$
$$N = 17$$
$$P = .43$$

This value of P, 0.43, affords additional strong confirmation of the cluster hypothesis.

Calculating the range that may be expected by means of the adjusted standard deviation, as before, we have (the mean cluster size for pigweed in timothy being nearly 1.5): -

TABLE 2.
DISTRIBUTION OF PIGWEED IN TIMOTHY. ANALYSIS RESULTS FROM 816 QUARTER-OUNCE REPLICATES.

Number of Pigweed Seeds Found	Number of Analyses		Number in which Found
		21	41	36	8
		22	53	37	11
		23	53	38	6
9	2	24	51	39	4
10		25	46	40	6
11	2	26	55	41	2
12	5	27	55	42	1
13	4	28	40	43	2
14	6	29	48	44	1
15	11	30	43	45	2
16	15	31	37	46	1
17	16	32	27		
18	29	33	17	Total	816
19	42	34	15		
20	44	35	15		

Mean Rate = 25 pigweed per quarter-ounce.

$$\text{Adjusted } \sigma_{(\text{Seeds})} = 1.5 \left(\frac{\sigma_m}{1.5} \right)$$

In the present case $\underline{m}$ was close to 25. This gives:-

$$\text{Adjusted } \sigma_{(\text{Seeds})} = 6.1$$

As before, the total range is covered by $\pm 3\sigma$ 8.e. 36.6. Actually the observed range was 37.

Discussion

Two main conclusions may be derived from this study with pigweed seed in red clover and in timothy seed.

(1) Provided we know certain constants characteristic of the two species being dealt with, we can predict (i.e., we know from calculation) what the expected range will be. It has been shown experimentally that the predicted range is closely followed.

(2) The expected range, when the impurity is smaller than the crop seed, is very much greater than would be expected in the case of seeds not differing in size and surface characters.

With regard to this second point, it is worth noting that it very much increases the difficulty of working seed legislation based on numbers per unit weight and forms a very potent argument in favour of percentage by weight, since in the

latter case the standard deviation drops from its adjusted value to a value $\frac{1}{c}$ as great. That is, for pigweed seed in red clover seed it is $\frac{1}{5}$ as great, for pigweed seed in timothy seed, 2/3 as great, when reported on the percentage by weight basis.

However, the difficulty is mitigated by the fact that in commercial seed the impurities are usually approximately the same size as the crop seed, thus the situation should not often arise. This, no doubt, would account for the rather uniformly "good fit" reported in similar experiments with commercial seed. Nevertheless, the possibilities we have been discussing should be kept in mind because mixtures of seeds of different sizes are fairly commonly found in commerce.

Red Clover in Alfalfa, and White Clover in Bluegrass

A similar study was carried out on red clover in alfalfa. It is not necessary to discuss the results in detail nor to present them here, but it may be stated that the cluster hypothesis did not apply, and that there was no indication of a significant departure from the expected distribution calculated in the regular way. The mean cluster size for red clover is 1.2, i.e. there is very little difference between the sizes of the two kinds, nor is there any specially marked difference in surface characters. Thus we may draw the conclusion that the cluster hypothesis is not applicable when there are insufficient differences in size, and surface characters. The study was done at the Toronto laboratory and comprised 10,000 trials of 100 seeds in each, 5% of red clover by number having been mixed into a lot of alfalfa.

The study of white clover in blue grass, comprising 9,918 trials of 100 seeds in each, was done in the Ottawa laboratory. This showed that a cluster hypothesis is applicable in this case, but the mean cluster size had to be determined empirically and we have not yet found the physical constants for two seeds of such diverse character by which to calculate the cluster distribution. Work on this is being continued.

Conclusions

The investigations we have been discussing were designed for a common purpose, namely to provide a picture of what is happening when seeds are being mixed and sampled, particularly where the impurity has characters of size, surface, texture, shape and density different from those of the crop seed in which it occurs. We find a very reasonable picture emerging in which seeds with smooth, shiny seed-coats tend to slip past other seeds and collect in little groups under the shelter, as it were, of the larger seeds in which they occur, these groups acting as units. When the seed-coat is smooth but not shiny, if the impurity differs markedly in size and is smaller than the crop seed, this same effect is in evidence, but when the seed-coat is roughened it may be several times smaller than the crop seed and not show the clustering effect. If, however, the seed-coat characters of the impurity and crop seed are not to be distinguished from one another, there is no cluster effect unless there is a marked difference in size.

This picture would not be of much use to us if we could not attach some numerical labels to it which will enable us to know what to do about it when we find it occurring in one of its manifestations. Mathematical methods of doing this have been worked out and developed to meet circumstances as they arose and

an indication of their nature has been given in the foregoing, but certain details require further work and elaboration.

As a general result of this study, then, we must recognize that, in certain circumstances, much wider variations may be expected than those to which we are becoming accustomed. These variations are much less on a percentage by weight basis than on the basis of numbers per unit weight.

Germination Tests

As stated before, 448 replicates of red clover and 816 of timothy were germinated. These comparatively large numbers of tests were made in order to secure results under regular laboratory conditions which would reveal what variations might be expected in practice and how these compare with statistical expectation and, further, which would provide a measure of the degree of experimental error if such exists to an appreciable extent.

Laboratories were requested to report the numbers of normal sprouts, abnormal sprouts, hard seeds, and dead seeds found in each of 4 x 100 seeds planted from each sample, the red clover tests being conducted both in sand and between blotters.

Methods of Interpretation used.

The total "error", that is, variation of individual tests from their average, is made up of two parts:

(1) The variation due to differences inherent in sampling

(2) Variation due to improper germinating conditions or interpretation of sprouts, or both.

Now, when interpreting results we assume that what is known as to statistical variation is applicable to the first cause of variation mentioned; namely, sampling variation. Any variation in excess of this is ascribable to improper germinating conditions and/or interpretation. If the observed variation is no greater than the statistical variation, then there is no reason to suppose that lack of uniformity in germination conditions or differences of opinion in interpretation have played any part in the observed variation.

It may be found that when the results of all laboratories are taken together, the variation is excessive. In such case it becomes necessary to examine the results of each laboratory separately. It may then quite well happen that within each separate laboratory the variation is found not to be excessive. This means that while the different laboratories do not quite agree as to interpretation, within any one laboratory the interpretation, such as they are, have been made consistently. This has been found quite often in the results which follow.

The chi-square test has been used in comparing observed with expected results. Where P is equal to 0.05 or more we may hold that there is no need to look beyond sampling variation to account for the results observed.

Presentation of Results

The results secured are too voluminous to give in detail, even when summarized. One complete table will be presented and two condensed tables showing typical distributions for average values of P and of the mean. The number of germinated seeds observed in any lot of 100 seeds set for germination is listed

in the left hand column. The figures in the right hand or succeeding columns show the number of times this particular result was obtained in any laboratory. Since, for red clover for example, each station tested 64 x 100 seeds, the numbers in any one station column will be found to add up to 64 and the figure in the column for all laboratories in Table 3 will be 7 times this number, or 448.

TABLE 3.
HARD SEEDS IN RED CLOVER TESTS.
BETWEEN BLOTTERS.

Per cent	STATION							All stations
	1	2	3	4	5	6	7	
0						1	1	2
1					1	1		2
2	1		1	1		2	3	8
3	2	1	2		2	5	4	16
4	3	5	2	4	2	9	9	34
5	7	5	5	3	6	10	9	45
6	5	10	8	6	8	9	18	64
7	13	9	10	11	6	11	3	63
8	5	10	8	10	10	6	4	53
9	7	12	12	12	4	5	5	57
10	15	3	9	7	10	1	4	49
11	3	2	4	6	5	2	1	23
12	2	3	1	1	3	1	1	12
13	1	3		2	4	1	1	12
14			1		3			4
15		1	1					2
16							1	1
17				1			1	1
Mean %	7.8	7.8	7.9	8.2	8.4	6.0	6.2	7.480
X^2								10.64
N								11
P								.47

The chi-square test on all laboratories is so good that detailed analysis of individual laboratories is not necessary. It will observed that the means of each laboratory are quite close and the value of P for all laboratories taken together, namely 0.47, is quite high.

Results with Red Clover Seed - Hard Seeds Between Blotters

Hard seeds were chosen for examination first, since here we should have no interpretational error nor should experimental error (germination conditions) appreciably affect hard seeds within wide limits in the case of red clover. Thus, we have a good opportunity of testing whether the samples were adequantely mixed in the first place, and whether the observed variations do or do not accord with expectation.

These results are presented in full in Table 3.

We may conclude definitely, therefore, that:-

(1) The samples were adequately mixed before being sent out, and

(2) The only source of variation in the present case is the natural variation of sampling - an irreducible minimum in a random distribution

Normal Sprouts between Blotters

The results for a typical laboratory are shown in the first double column of Table 4.

TABLE 4.
GERMINATION OF RED CLOVER - RESULTS FROM SELECTED LABORATORIES HAVING AVERAGE VALUES OF P AND OF THE MEAN.

Normal B.B.		Abnormal B.B.		Dead B.B.		Normal sand		Abnormal sand	
Per cent	Tests	Per cent	Tests	Per cent	Tests	Per cent	Tests	Per cent	Tests
		2							
		3	1						
69		4				69			
70	1	5		0	20	70	1	0	
71		6	2	1	25	71	1	1	2
72		7		2	9	72		2	10
73	1	8	2	3	4	73		3	12
74	3	9	3	4	3	74	2	4	13
75	1	10	3	5	2	75	3	5	15
76	2	11	7	6	1	76	1	6	7
77	1	12	1	7		77	2	7	1
78	3	13	7			78	1	8	2
79	2	14	6			79	3	9	2
80	8	15	6			80	8	10	
81	6	16	6			81	6		
82	4	17	9			82	5		
83	7	18	2			83	6		
84	8	19	4			84	6		
85	2	20				85	7		
86	6	21	3			86	6		
87	2	22	1			87	1		
88	3	23				88	2		
89	1	24	1			89	2		
90	2	25				90			
91	1					91	1		
92						92			
Mean	82.1		14.3		1.3		81.9		4.2
X^2	11.0		11.6		3.0		7.8		3.0
N	11		9		2		10		4
P	.40		.24		.22		.60		.57

Since germination standards are based on normal sprouts, it is of course highly desirable that different laboratories should interpret them accurately and uniformly. The results showed that no individual laboratory had a value of P less than 0.25, which is a moderately high value. However, when all laboratories were taken together, P was less than 0.01. The means of the laboratories ranged from 76.2% to 83.9%; the P values from 0.25 to 0.70.

These results show that, while each laboratory has learned to interpret uniformly according to its own standards, the basis of interpretation differs somewhat in different laboratories. The sand tests, to be discussed later would indicate that the more liberal interpretations were more nearly correct.

We may conclude from this part of the study that if the basis of interpretation for the judgment of clover seedlings could be unified throughout our laboratory system, there is every reason to suppose that no greater variation need be encountered than that inherent in sampling.

ABNORMAL SPROUTS AND DEAD SEEDS. BETWEEN BLOTTERS

The results reveal a condition somewhat similar to that just discussed, except that the degree of uniformity within any laboratory was slightly lower. There seemed to be uncertainty in interpretation as between abnormal sprouts and dead seeds, but as this was inevitably in relation to abnormal sprouts so bad as to be nearly dead, such uncertainty is not of the least practical consequence.

Means of abnormal sprouts	8.4% to 15.8%
P values " "	.08 to .95
Means of dead seeds	.3% to 2.6%
P values " "	.02 to .45[1]

Normal Sprouts - Sand

Two stations obviously experienced difficulty in conducting the sand tests. For the remaining five stations the means were more uniform than in the blotter tests, the range being from 80.7 to 85.7% - a difference of 5% as compared with 76.4 to 83.9 - a difference of 7.5% - for the same stations in the blotter tests. The P values for the five stations ranged from 0.4 to 0.9. The chi-square tests on the combined results for the five stations gave a P value of less than 0.01 however, indicating that the variations in the means of the stations are more than random fluctuations.

The five individual stations have shown excellent agreement between observed and expected results, thus there is no question that with further unification of methods and interpretation in sand tests close concordance could be secured between the different stations.

Abnormal Sprouts - Sand

The function of a sand test is to provide a means whereby abnormal sprouts may be impeded to the point of failure to penetrate to the surface. Thus, comparatively few abnormal sprouts should be seen in a properly conducted sand test,

[1] One laboratory had too few classes for this test but goodness of fit was high - equivalent to about 0.9.

such sprouts usually being confined to "watery" and those lacking cotyledons, both of which kinds often seem capable of penetrating. In these tests, however, the great variation in number of abnormal sprouts, namely 0.2% to 14.4% would indicate uneven conditions in the tests as between laboratories, although within laboratories conditions and interpretations were reasonably uniform, individual P values ranging from 0.08 to 0.81, except for one station for which P = < .01. Thus these results confirm the conclusions drawn from the study of normal sprouts.

Timothy

Table 5 presents typical results from selected laboratories with average values of P and of the mean.

Normal Sprouts. Top of Filters

The sample of timothy was of very high viability and thus was possibly not the most suitable for a study of this kind. For such a high germination (highest results 97.5%) the permissible variation is very small. Any slight variation in germination conditions would tend to upset the statistical agreement badly.

The results were not as good as for red clover but tolerable uniformity within each laboratory (except one) was secured, P values ranging from less than 0.01 to 0.48. The means ranged from 92.6% to 97.5%, a range which is altogether excessive for seed of this quality, considering that each mean is based on more than 11,000 seeds. Without going into detail, it may be stated, briefly, that study of the results led to the conclusion that experimental rather than interpretational error was the main factor leading to irregularity of results. This should be comparatively simple to correct, and when corrected, there is every reason to expect that no greater error than sampling error need affect results secured on a properly mixed and sampled bulk, by widely separated stations.

Abnormal sprouts, ungerminated and dead seeds exhibited corresponding variations but do not afford material for discussion here.

Conclusions.

As a result of this germination study, we can draw certain definite conclusions.

(1) Hard seeds in red clover, in which no question arises as to interpretation and experimental error, follow expectation strictly and are subject to no error other than sampling error. This proves:

(a) That the samples were properly mixed and sampled

(b) That the adequacy of the bulking of a lot of seed is reflected in tests made under ordinary laboratory conditions by widely separated laboratories.

(2) It has been shown that it is quite possible, under ordinary laboratory conditions, to secure germination results on timothy and red clover which reveal only the natural variation inherent in sampling.

(3) Differences in the basis of interpretation, while not affecting conclusion (2) do bring about differences between laboratories.

(4) These differences are not very great, amounting on the average, to about 5%.

TABLE 5.
GERMINATION OF TIMOTHY - RESULTS FOR SELECTED LABORATORIES, HAVING AVERAGE VALUES OF P AND OF THE MEAN.

	Normal		Abnormal		Fresh		Dead	
	Per cent	Tests	Per cent	Tests	Per cent	Tests	Per cent	Tests
			0	5	0	95	0	9
	86		1	14	1	23	1	22
	87	1	2	22	2	6	2	37
	88	1	3	23	3		3	20
	89	1	4	22			4	11
	90	1	5	13			5	7
	91	5	6	5			6	4
	92	10	7	6			7	2
	93	9	8	3			8	
	94	22	9	1			9	1
	95	15	10				10	1
	96	18	11	1				
	97	14	12	1				
	98	15	13					
	99	4	14					
	100		15					
Mean	94.9		3.52		0.28		2.56	
X^2	7.8		6.6		1.33		6.6	
N	6		5		1		5	
P	.25		.25		.25		.25	

(5) There is a distinct tendency for stations reporting high results on timothy to report high results on red clover and vice-versa.

(6) All laboratories require some unification of the basis of interpretation both for timothy and red clover to bring them into line with each other.

There is a final point which must be mentioned to tie up the foregoing with other work relating to the statistics of seed testing.

The writer has published various papers in which the validity of the argument depends upon observed results of seed testing and analysis being in accordance with statistical expectation. Evidence, of which this paper forms a part, is accumulating to show that this is the case. This gives us a definite goal towards which we must aim in our attempts to perfect our laboratory work, a goal which is clearly defined and entirely practical.

CHEMICAL CONTROL OF MOLDS WHEN GERMINATING LIMA BEANS[1]

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The accuracy of germination tests of lima beans often may depend more upon the freedom from microorganic contaminants than upon any other environmental factor. As emphasized previously before this association, every seed should be permitted to germinate and every seedling to develop independently of the other seeds or seedlings on the same germinative substratum. Furthermore, the associated microorganisms of any seed should be prevented from interfering, either mechanically or physiologically, with the neighboring germinants.

The exponents of wide spacing of lima beans realize these requirements for accurate appraisal of viability and attempt to localize the contaminants spacially. Other investigators have expressed a preference for a solid germinative medium. Their desire appears to be simply to separate the seeds so as to reduce the influence of fungus contaminants on the adjacent seeds. Without proper regard for the type of substratum, however, fungus injury may be enhanced. A substratum with a low inoculum potential is always desirable to one containing microorganisms. Soil, sand, wood shaving, or any other type of medium, however, does not prevent the growth of fungi or exert a marked mechanical limitation to their spread. A sample of fungus-contaminated seeds may be ruined, or at least the accuracy of the test impaired, even though it was germinated in sterilized soil.

A chemical method of protection from microorganisms has been suggested by Hay (3)[2], Porter (4), Davis (2) and Crosier (1) in their reports on germination studies with beans, corn, peas and certain smaller seeds. Results of experimentation with lima beans have not been presented previously. Observations made in our laboratory indicate that samples of lima beans vary markedly in severity of fungus infestations. Many samples were clean and required no protection. Others contained many dead, fungus-infested seeds and accurate determinations of normal seedlings were dependent on elimination of the fungi.

Several chemicals and methods of application have been studied in an attempt to develop a treatment which would be protective to the heavily contaminated seedstocks but neither injurious to, nor wasteful of time when treating, clean lots of seed.

A large number of materials are now available for applying to seeds. Several were developed for, and should be used only as, disinfestants, disinfectants, protectants or sterilizants. A few from each group were included in this study. They were applied by both the dust and dip methods. The former necessitated the agitation of seeds and dust in a flask followed by removal of the non-adhering material. The latter consisted of dipping the seeds in a solution or suspension of the chemical followed by momentary draining of the excess liquid. The dip method has the obvious advantages of conservation of both time, and material, uniform dosage and elimination of health hazards. The principal characteristics of each material with the method of applying it, are given in Table 1. Mercuric chloride is unique among the 19 chemicals in being soluble in water, non-volatile

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[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 276

[2] Numbers in parenthesis refer to Literature Cited.

TABLE 1.
CHARACTERISTICS AND METHODS OF APPLICATION OF CERTAIN MATERIALS USED IN TREATING LIMA BEANS PRIOR TO GERMINATION.

Name of material	Used as	Solubility in water	Vola-tile	Applied as	Active ingredient
1. Ammonium sulfate	Eradicant	Very	No	Dip	Pure chemical
2. Barbak C.	Protectant	Slight	No	Dust	Phenyl mercuric cyanamide
3. Ceresan	Disinfectant	Very	Yes	Either	Ethyl mercuric chloride
4. Copper hydroxide	Protectant	Slight	No	Dust	Pure chemical
5. Copper oxychloride	Protectant	Slight	No	Dust	Pure chemical
6. Copper stearate	Protectant	Slight	No	Dust	Pure chemical
7. Copper sulfate	Disinfectant	Very	No	Both	Pure chemical
8. Cuprous oxide	Protectant	Slight	No	Dust	Pure chemical
9. Ferrous sulfate	Eradicant	Very	No	Dip	Pure chemical
10. Mercuric chloride	Sterilizant	Very	No	Either	Pure chemical
11. Mercurous chloride	Insecticide	Slight	No	Dust	Pure chemical
12. Merko	Disinfectant	Slight	No	Dust	Metallic mercury
13. New Ceresan, clay	Disinfectant	Very	Yes	Both	Ethyl mercuric phosphate
14. New Ceresan, copper stearate, clay	Protectant	---	Yes	Dust	See each ingredient
15. New Semesan Jr.	Disinfectant	Very	Yes	Dust	Ethyl mercuric phosphate
16. Phenyl mercuric nitrate	Disinfectant	Slight	No	Dust	Pure chemical
17. Potassium dichromate	Sterilizant	Very	No	Dip	Pure chemical
18. Sanoseed	Disinfestant	Slight	No	Dust	Ethanol mercuric chloride
19. Semesan	Protectant	Very	Yes	Dust	Hydroxymercuri-chlorophenol

and useful as either a dip or dust. Furthermore, it is a very active fungicide and may be mixed with five times its volume of an inert dilutant. None of the slightly-soluble materials have proven successful as dips. They possess high sedimentation potentials and remain in suspension in water only when agitated. The volatile dusts should not be used unless adequate ventilation is provided to remove the volatilized mercury.

Each of the materials was tested on a number of individual lots of lima beans. Since large contaminated bulks were not available, comparisons including every chemical could not be conducted with the same lot of seed. The data in Table 2 are averages of all the tests made with a certain concentration or dilution of each material. The germinative conditions were not held constant for every chemical but the treated and untreated portions of each lot of lima beans were always placed on the same germinator tray to insure identical environments.

By and large, the mercury compounds have proven the most successful as well as the easiest materials to apply. The copper compounds often did not provide uniform coverings and were markedly phytotoxic. Ammonium sulfate, ferrous sul-

TABLE 2.
INFLUENCE OF CERTAIN SEED TREATMENTS ON THE GERMINATION AND SAPROPHYTIC ASSOCIATES OF LIMA BEANS AND ON THE DEVELOPMENT OF, AND INJURY TO, THE GERMINANTS

Treatment	Germination	Saprophytic[1] contaminations				Length		Weight sprouts	Chemically injured tests
		Black mold	Green mold	Black spot	Bacteria	Plumules	Radicles		
	%	%	%	%	%	Ins.	Ins.	Grams	Ratio
Ammonium sulfate,5% dip	89	42	1	70	6	0.6	1.9	88.0	2/4
Check	95	23	2	95	4	0.8	2.6	92.0	---
Barbak C dust	88	4	0.3	0	1	0.7	2.9	60.7	1/3
Check	71	34	12	33	14	0.7	2.8	64.0	---
Ceresan,1.0% dip	91	6	1	0.3	1	1.9	3.8	62.7	2/12
Check	90	55	34	35	4	1.7	3.0	65.1	---
Ceresan,1.5% dip	72	8	6	0	18	0.9	1.9	85.0	0/3
Check	61	51	40	3	20	0.6	1.7	84.0	---
Ceresan,2.0% filtered dip	83	0	0	0	13	0.7	1.9	82.3	1/3
Check	79	46	24	0	13	0.7	2.0	84.3	---
Copper hydroxide,1% dip	81	43	39	17	7	1.9	4.1	90.5	1/3
Check	85	20	33	56	6	2.5	4.1	100.5	---
Copper oxychloride,1% dip	74	22	2	2	8	---	---	----	0/5
Check	75	32	5	18	12	---	---	----	---
Copper oxychloride,3% dip	70	57	23	0	8	---	---	----	0/3
Check	68	73	32	0	28	---	---	----	---
Copper stearate, dust	87	16	2	2	6	1.1	2.2	80.7	2/6
Check	92	23	4	22	5	1.4	3.0	95.5	---
Copper sulfate,1/4 to 1% dips	84	37	17	21	2	---	---	----	1/5
Check	84	28	40	62	0.4	---	---	----	---
Cuprous oxide, dust	76	13	8	4	5	---	---	87.3	4/5
Check	72	32	14	43	6	---	---	92.0	---
Cuprous oxide,50% dust	75	38	15	0	4	---	---	----	1/3
Check	67	46	24	0	8	---	---	----	---
Cuprous oxide,1% dip	76	60	5	20	11	---	---	87.0	2/3
Check	85	31	0	50	11	---	---	100.0	---
Ferrous sulfate,10% dip	80	48	11	0	10	0.7	1.1	87.3	2/3
Check	90	30	6	33	6	0.8	2.2	91.0	---
Mercuric chloride,17% dust	91	1	2	1	5	0.5	0.6	85.8	7/10
Check	94	51	12	23	11	0.9	1.8	94.6	---

[1]Black mold refers to Rhizopus nigricans, green mold to Penicillium spp. and black spot to Dematium pullulans.

TABLE 2 - (Continued)

Treatment	Germination	Saprophytic[1] contaminations				Length		Weight sprouts	Chemically injured tests
		Black mold	Green mold	Black spot	Bacteria	Plumules	Radicles		
	%	%	%	%	%	Ins.	Ins.	Grams	Ratio
Mercuric chloride,0.18% dip	82	10	0	0	4	---	---	85.0	0/3
Check	83	45	0.3	83	7	---	---	88.3	---
Mercuric chloride,0.25% dip	88	10	3	0.2	2	1.1	2.4	83.4	7/19
Check	85	56	28	8	8	1.2	2.3	90.6	---
Mercuric chloride,0.40% dip	90	2	0	0	0	---	---	---	0/3
Check	87	10	67	100	0	---	---	---	---
Mercurous chloride,dust	83	6	15	1	19	0.5	0.5	88.0	11/12
Check	88	48	18	26	5	1.1	1.6	108.8	---
Mercurous chloride,1½% dip	89	67	14	1	6	0.9	1.0	75.0	10/10
Check	91	48	22	16	4	1.4	1.4	86.8	---
Merko, dust	77	6	5	0	0	---	---	---	1/2
Check	60	65	34	0	13	---	---	---	---
Merko, 2.0% dip	85	12	2	0	3	---	---	---	0/5
Check	75	32	5	18	12	---	---	---	---
New Ceresan, 17% dust	85	3	1	0	0.4	---	---	86.7	1/14
Check	77	40	15	16	7	---	---	90.0	---
New Ceresan, 9% dust	86	13	3	0	1	---	---	85.0	0/4
Check	68	51	20	0	11	---	---	82.0	---
New Ceresan,0.15% dip	85	3	0	0	2	---	---	80.3	0/9
Check	85	30	0	51	7	---	---	80.0	---
New Ceresan,0.18% dip	88	3	2	1	1	---	---	88.5	1/10
Check	75	61	17	50	10	---	---	93.2	---
New Ceresan,0.18% dip	81	2	3	0.3	1	---	---	---	0/11
Semesan, 1.0% dip	80	5	3	0.3	1	---	---	---	0/11
Check	78	27	41	16	4	---	---	---	---
New Ceresan,0.25% dip	89	5	1	0	4	0.8	1.9	81.3	0/3
Check	79	21	7	7	9	0.6	2.0	68.0	---
New Ceresan,0.30% dip	83	0.3	0.1	1	4	1.2	2.8	83.5	1/17
Check	80	37	17	54	6	1.0	2.4	71.2	---
New Ceresan,0.3% filtered dip	72	13	3	1	17	0.7	2.3	82.0	0/10
Check	56	87	27	3	33	0.6	1.9	84.0	---
New Ceresan, copper stearate	81	0	0	0	0	---	---	82.8	1/4
Check	82	29	0.2	79	1	---	---	86.0	---
New Semesan Jr., dust	89	4	1	0.3	2	1.0	2.6	85.6	2/7
Check	89	49	11	3	8	1.0	2.6	92.1	---
Phenyl mercuric nitrate, 25% dust	93	0	3	11	1	0.9	1.1	68.0	2/2
Check	94	9	75	0	5	3.1	3.5	73.0	---

TABLE 2 - (Concluded)

Treatment	Germination	Saprophytic[1] contaminations						Weight sprouts	Chemically injured tests
		Black mold	Green mold	Black spot	Bacteria	Plumules	Radicals		
	%	%	%	%	%	Ins.	Ins.	Grams	Ratio
Potassium dichromate, 5% dip	58	70	5	0	17	0.5	0.6	87.2	5/6
Check	58	88	48	0	47	0.9	1.3	82.8	---
Sanoseed, 2.0% dip	84	14	0	0	7	1.2	2.5	81.0	0/3
Check	81	49	21	0	23	1.2	2.6	80.0	---
Semesan, dust	83	5	0	0	2	---	---	---	1/5
Check	75	32	5	18	12	---	---	---	---

fate and potassium dichromate should not be considered as seed protectants. They probably have no value for this purpose. Several other chemicals, namely, potassium iodide, sodium hypochloride, borax and sodium bicarbonate have been studied and likewise were found to injure the germinants without reducing the incidence of contamination. The relative fungicidal efficiency of the various materials is apparent in Table 2. Barbak C, Ceresan, mercuric chloride, New Ceresan and combinations containing New Ceresan greatly reduced or completely eliminated the microorganisms. Ceresan was more effective in a 2.0% dip than in either the 1.0 or 0.5% concentrations. New Ceresan and mercuric chloride were far more efficient in that 0.15 to 0.40% solutions effected practical control of saprophytes. On a cost basis New Ceresan is much the cheapest of any seed protectant. The material in the one-pound container, costing seventy cents, may be reduced with five parts of an inexpensive dilutant or added to about 500 pints of water. Ceresan which can be diluted in the dust form, costs about seven times as much as the diluted New Ceresan. Most of the other materials are somewhat more expensive.

Chemical injury to the seedlings rarely increased the difficulty of differentiating the strong from the weak sprouts.

The slight reduction in green weight of seedlings or of lengths of plumules and radicles in the mercury treated samples little effected their readibility. Injury could be prevented entirely in the dip treatments and usually without a sacrifice of fungus control. The dusts were more difficult to apply uniformly and a few injured sprouts were present in several tests. The length of time involved in shaking the seeds to remove the excess dust had an important bearing on injury. When only the material actually adhering to the seeds was left, no phytotoxicity was observed. If an excess remained the sprouts in contact with the residue were often deformed or killed.

Mercurous chloride dust has not proven decidedly injurious to peas and corn. The 12 samples of lima beans used in this study were damp and an unusually heavy dosage of mercurous chloride was obtained. Unless the seeds are thoroughly dry or the chemical is reduced with a dilutant, an excessive covering is secured with any material.

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DETECTION AND CLASSIFICATION OF SEED-BORNE ORGANISMS, THEIR EFFECT ON GERMINATION AND THEIR CONTROL BY SEED DISINFECTION IN LABORATORY AND FIELD.[1]

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One of the major functions of a seed laboratory is to determine the viability of seed lots from samples submitted for tests. One factor which frequently has a marked effect on the germination of seeds is their pathological condition. Unfortunately, the amount of time which has been devoted to an investigation of the relation of organisms to seed viability has been disproportionate to their importance, with the result that seed analysts are frequently unable to interpret the value of a given seed lot, and wide differences in judgment inevitably result.

Within recent years the writer and his associates (5, 9, 10, 11, 12, 13)[2] also Crosier (1, 2, 3, 4) and others associated with him have published several papers dealing with certain phytopathological aspects of seed testing. The manifest interest of seed analysts in general in this important phase of seed testing is encouraging; however, much confusion and misunderstanding of the subject still exists.

The purpose of the present paper is to describe briefly the results of attempts in the Iowa State College Seed Laboratory to utilize certain phytopathological techniques in laboratory practice. Inasmuch as a part of the material herein presented is based either on material in standard text books or on experience and research data already published, no extensive review of the literature is given. An exceedingly useful list of seed-borne parasites has been prepared by Orton (8).

To utilize the techniques in plant pathology and apply them to seed laboratory practice it is first necessary to become familiar with the classification of micro-organisms, after which methods for their detection and control may be undertaken. This discussion, therefore, centers around the following three aspects:

I. Classification of organisms and disease-producing entities carried by seeds and vegetative reproductive organs.

II. Detection, by symptoms, of organisms and other disease- producing entities on germinating and non-germinating seeds.

III. Classification of seed disinfectants, methods of application and effect of same on seed germination in both laboratory and field.

I. Classification of Organisms and Disease-Producing Entities Carried by Seeds and Vegetative Reproductive Organs

Micro-organisms and other entities transmitted by seed may be classified in various ways, for example, according to morphology, symptoms, host relation, parasitism and effect on the host. An outline explaining the morphological classi-

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[1] Journal paper No. 583 of the Iowa Agricultural Experiment Station. Project No. 427.

[2] Numbers in parentheses refer to Literature Cited.

fication is given in chart form and is designated as Table 1.

TABLE 1.
CLASSIFICATION OF SEED-BORNE ORGANISMS AND OTHER ENTITIES ON THE BASIS OF MORPHOLOGY.

Class	Common name	Illustration	Causal entity
Schizomycetes	Bacteria	Black rot of cabbage	Pseudomonas campestris
Phycomycetes	Water molds	Downy mildew of millet	Sclerospora graminicola
Actinomycetes	Gall fungi	Powdery scab of potatoes	Spongospora subterranea
Ascomycetes	Sac fungi	Scab of sereals	Gibberella saubinetii
Basidiomycetes	Stalk fungi Smuts	Bunt of wheat	Tilletia tritici
Fungi Imperfecti	Imperfect fungi	Stripe of barley	Helminthosporium gramineum
Viruses	Mosaics Streak Yellow dwarf	Yellow dwarf of onions	
	Nematodes	Wheat head Nematode	Tylenchus tritici

Other methods of classification are as follows:

B. Host Relation.

1. Systemic - involving the whole system of the plant, starting with the germinating seed and continuing throughout the life of the plant. Examples are loose smuts of wheat and barley, smuts of oats, kernel smuts of sorghum and millet, flag smut of wheat, black smut of rice, stripe of barley, fusarial wilts of cabbage, cotton, flax, watermelons and tomatoes, black bundle disease of corn, bean mosaic, and yellow dwarf of onions.

2. Non-systemic - causing local infections only. Examples are scab of cereals, foot rot and spot blotch of barley, Diplodia and Nigrospora dry rots of corn, anthracnose of beans, sorghum, cotton and cereals, fruit rot of egg plant, Ascochyta blight of peas and black leg of cabbage.

C. Mode of Dissemination.

1. Externally as fruiting bodies, spores, mycelia, bacteria or viruses. Examples are kernel smuts of millet and sorghum, bunt of wheat, fusarial wilts of tomato and watermelon, black rot of cabbage, angular leaf spot of cucurbits and tomato mosaic. Ergotized grains and smut balls may also be included in this class.

2. Internally as mycelia, bacteria or viruses. Examples are loose smuts of wheat and barley, bean blight, bean mosaic, and yellow dwarf of onion.

3. Both externally and internally. Examples are scab of cereals, stripe of barley, black leg of cabbage, foot rots of cereals (Helminthosporium), leaf spot and blight of peas, anthracnose of cotton

and beans and Diplodia, Nigrospora and Fusarium dry rots of corn.

D. Relation of Presence of Causal Agent on Seed to Development of Disease.

The development of certain diseases is primarily dependent on the presence of the causal agent in or on the seed, whereas other diseases are dependent only in part on seed transmission of the causal entity. Causal agents may, therefore, be placed in one of four classes for the purpose of this paper, as follows:

1. Entirely seed-borne, that is, the causal agent must be present in or on the seed and produce primary infection when the seed is germinating. Examples of this class include the smuts of barley, oats, millet, rye, rice, and wheat, also kernel smuts of sorghum and barley stripe. The mere presence of the pathogens on the seed does not insure infection because primary infection is dependent on those environmental factors which favor infection.

2. Partially seed-borne, that is, the causal agent when present on the seed may cause blight or other symptoms of disease but subsequent infection on other parts of the plant may occur independently of the seed infestation inasmuch as the causal agent is able to maintain a saprophytic existence on crop residue or on other hosts. Examples of this class are Diplodia, Nigrospora, Gibberella and Fusarium dry rots of corn, scab of cereals, foot rots of cereals, net blotch of barley, anthracnose and Septoria diseases of cereals and sorghum, anthracnose of beans, cotton, peas, and tomatoes, leaf spot and blight of beans, fruit rot of egg plant, many potato virus-diseases, yellow dwarf of onion, and common scab and black scurf of potatoes.

3. Systemic organisms which must enter the host at the time of germination to bring about infection but which may be present in the soil as well as on the seed. Examples of this class are the organisms which cause bunt and flag smut of wheat and onion smut.

4. Systemic organisms which may be carried by seed or soil and may cause infection from the time of seedling development until the plants are nearly mature. Examples of this class are those organisms which cause fusarial wilts of cabbage, celery, pea, bean, tomato, flax, cotton, watermelon, sesame, potato, and sweet potato.

E. Parasitism

1. Micro-organisms have been classified into two major groups, namely, parasitic and saprophytic, however, the line of demarcation is quite artificial, in that certain ones may act either as parasites or saprophytes, depending on environment. A convenient grouping is as follows:

a. Obligate parasites - those which derive their food only from living plant tissue. The powdery mildew, smut, and rust fungi are commonly classed in this group.

b. Facultative parasites - those which are normally saprophytes but may live a parasitic existence. Rhizopus nigricans and Aspergillus niger belong in this class.

c. Obligate saprophytes - those which derive their food only from dead plant tissue. Many of the wood rot fungi belong in this class.

d. Facultative saprophytes - those which are normally parasitic but may become saprophytic under certain conditions. The organisms causing cabbage yellows, watermelon wilt, and bunt of wheat belong in this class.

F. Effect on Seed Viability

1. Germination impaired, the symptoms of which include seed rots, damping-off, seedling blights, dwarfing, etiolation, leaf spots, smuts, and many others.

2. Germination impaired little or not at all.

In this class may be listed most of the cereal smuts including smuts of oats, barley, rye, rice, millet, loose and stinking smuts of wheat and kernel smuts of sorghum. In some cases the smut pathogens have been known to cause stunting but this is not usually severe.

II. Detection, by Symptoms, of Organisms and Other Disease-Producing Entities on Germinating and Non-germinating Seeds.

The ability to detect those agencies which cause diseases of seeds and seedlings depends on a knowledge of the causal agents and of the environment that surrounds the seeds and young seedling. To intelligently undertake a program in a seed laboratory for the detection of seed-borne organisms, it is necessary to know something of the nature of each organism, its effect on the host and the factors which affect the interaction of host and parasite. The following outline will indicate the information needed to undertake a comprehensive program dealing with the pathology of seeds.

1. Causal organism or entity and its morphological characteristics.
2. Effect of environment on the parasitism of the organism or the expression of disease symptoms including:
   a. Cardinal temperatures, especially optimum
   b. Moisture relations
   c. Light
   d. Substrata
3. Stage of plant development at which symptoms appear.
4. Symptoms of the disease on all parts of the seedling attacked.
5. Longevity of the organism or entity in the seed.
6. How the organism is carried by the seed.
7. Response of infected or infested seed to treatment.
8. Specific fungicides for different kinds of seeds.
9. Field methods for the control of the causal agent.

Techniques for Detection of Organisms.

a. Saprophytic Fungi.

Several techniques have been used in the Iowa Laboratory as aids in the detection of organisms carried by seeds. These depend on the organism and host concerned and on the symptom which it is desired to have appear.

Seeds which are dead or low in vitality are more frequent carriers of facultative parasites than living seeds are, although the environment under which seeds are produced, such as exposure in the field, methods of drying and handling,

duration and place of storage are factors which affect the microfloral content of seed lots. Seeds of sorghum and onion are frequently contaminated with facultative parasites which overrun blotter tests and injure otherwise normal seedlings. This condition also appears commonly on cabbage, parsnips, watermelon, and cereal seeds that are low in vitality, whereas sorghum seeds with either high or low vitality are more commonly infested with normally saprophytic organisms. Seeds of corn from inbred and hybrid lots, even though high in vitality, are frequent carriers of species of Aspergillus, Penicillium, Rhizopus, Mucor, and Alternaria. A seed lot so infested may be rated much lower than it deserves by those unfamiliar with such fungi, because such organisms do not usually cause serious losses in the field, except under conditions unfavorable to seed germination and highly favorable to the growth of these fungi.

One of the most difficult problems, when seed lots infested with facultative parasites are involved, is to fairly interpret their plant-producing power. It is not a sound policy to treat such seed even with a surface sterilant and use the results obtained as a measure of seed viability because a seed analyst must deal with the sample as received. Any laboratory treatment which may give an incorrect measure of the quality of the sample in the field, unless the same treatment be employed by the patron, is unwise. On the other hand, an analyst must be cautious about rating a sample too low because of the injury which certain organisms may cause to germination under the artificial conditions of the laboratory.

Blotters have long been used as a substratum for seed germination but they provide a rather favorable environment for the spread of many saprophytic fungi, especially when folded. For the past eight years the Iowa Laboratory has tried several types of substrata in the hope of finding something superior to blotters for the germination of certain types of seeds. Cellucotton, common cotton, blotters, soil (equal parts of sand and compost, autoclaved), and more recently different grades of silica and builder's sand have been used. Up to the present time either pure silica or builder's sand reasonably free from organic matter has proved valuable as a substratum. Data obtained from the comparison of several substrata will be published in the near future.

Recently an attempt has been made to determine the relative rates of growth of several types of organisms in soil, silica and sand. Mr. Charles Gould has made some preliminary studies and the writer is indebted to him for information which suggests that although individual hyphae may extend for a considerable distance in both sand and silica, the growth is much more dense, in autoclaved soil, moving forward almost "enmasse." Mr. Gould found that at the end of 12 days Aspergillus niger and Pythium debaryanum had made between 50 and 65% more growth (in distance traveled) in soil than in builder's sand. Penicillium sp. grew slightly more in sand than in soil. The growth in pure silica of Aspergillus niger, Penicillium sp. and Pythium debaryanum was less than in either sand or soil. There are many difficulties involved in a study of the growth of organisms in soil or sand, among which are problems of measurement of growth, number of replicates needed and comparison of the behavior of pure and mixed cultures. In the light of our present knowledge it seems that from the practical standpoint more comparisons are needed between field and laboratory response both in sand and soil. Experimental results obtained to date indicate that sand is a superior medium for testing seeds infested with normally saprophytic fungi.

b. Parasitic fungi

The detection of pathogenic fungi and other disease-producing entities

carried by seeds is probably of far more significance than the detection of saprophytic forms, inasmuch as the seed harvested may be dependent on freedom from certain diseases during the growing season. The techniques that may be used for the detection of parasitic fungi are numerous and the environmental conditions to be provided for the expression of fungous symptoms are frequently not the optimum for the germination of the seed in question. The methods which have been used in the Iowa State College Seed Laboratory are presented in outline form as follows:

1. Washing seeds in sterile water either with or without a centrifuge followed by a microscopic examination of the water for the presence of spores. This method is particularly valuable for the determination of smut spores on barley, millet, oats, rice, rye, sorghum, and wheat. Davis (5) has shown that by use of a haemocytometer it is possible to approximate the number of spores carried per kernel. The method is somewhat tedious and has value primarily in research involving correlation of laboratory spore load and percentage of smutted plants which develop in the field. Determination of spore load for species of Fusarium, Helminthosporium, and Alternaria as well as other genera may be made by the same method. This method has been used with the following crop seeds:

Kind of Crop	Organisms detected
Barley	*Ustilago hordei*
	Helminthosporium spp.
	Alternaria spp.
	Fusarium spp.
Millet	*Ustilago crameri*
	*Sclerospora graminicola**
Oats	*Ustilago avenae* and *levis*
	Helminthosporium spp.
	Alternaria spp.
	Fusarium spp.
Rye	*Fusarium* spp.
	Helminthosporium spp.
Sorghum	*Sphacelotheca cruenta*
	S. sorghi
	Colletotrichum lineola
	Alternaria spp.
Wheat	*Alternaria* spp.
	Helminthosporium spp.
	Tilletia foetans
	T. tritici
	*Urocystis tritici***

* Oospores commonly detected in millet seed from Shantung Province, in China, by the writer.

** Commonly found on wheat kernels in China by the writer.

Wheat (Cont.) *Aspergillus* spp.
Penicillium spp.

The disadvantage of this method is that no estimate of the percentage of infested kernels can be made.

2. Microscopic examination of fruiting bodies on surface of seeds and glumes of grass fruits. The writer has observed the pycnidia of *Phoma insidiosa* on the outer glumes and pericarp of sorghum and pycnidia of a *Phoma* sp. on the outer glumes of *Setaria italica*.

3. Macroscopic examination of seed lots for sclerotia of *Claviceps* spp. and smut balls. The ergotized grains of rye, barley, wheat, bluegrass, redtop, rye grass, timothy, and other grasses are frequently found in seed samples. Likewise smut balls and masses of *Tilletia* spp. in wheat, *Ustilago hordei* in barley, *Ustilago striaeformis* in redtop, *Sphacelotheca sorghi* in sorghum and mummies of *Tylenchus tritici* in wheat samples are readily detected.

4. Plating seeds in agar. Practically all seeds may be studied by this method. Prior to plating, it is necessary to use a surface sterilant on the seeds to prevent the rapid growth of many surface-borne, normally saprophytic forms which grow so rapidly that parasitic forms may be masked. Hydrogen peroxide and chlorox each diluted one part to nine parts of water are satisfactory surface sterilants. The disadvantages of this method are:

1. Much time is required and only a small seed population can be examined.

2. Some of the parasitic forms which are surface-borne may be destroyed, resulting in an incorrect measure of the percentage of seeds infected.

The method is exceedingly important in research and possibly can be more widely adapted to seed laboratory practice.

5. Germinating seeds on top of moist blotters.

When the program for the detection of dry rot fungi on corn was initiated in 1921, the rag doll and later the modified rag doll was used to test the seed. This method is objectionable in that the kernels are placed so close together that fungi spread readily from one part of the doll to another. Beginning in 1931, the seed laboratory used trays of sand covered with muslin as the substratum and a plate of glass for the cover to prevent rapid loss of moisture. The kernels were carefully spaced in the tray so that each could be examined independently for the presence of any fungous growth. Later, large galvanized iron trays filled with water and equipped with copper screens and wicks, on which blotters were placed, have been in constant use. Each kernel is spaced by means of a 100-kernel counter constructed of pressed wood.

The experience with corn led to the adoption of similar methods for barley, oats, rye, sorghum, wheat, timothy, brome grass, rye grass, orchard grass, and redtop. The cereal seeds, sorghum, and timothy are spaced by means of a vacuum seed counter plate which places them on top of 18" x 18" germinating blotters with a plate of heavy glass of the same dimensions underneath. The glass rests on a copper or galvanized iron tray which can be moved easily from one germinator to another. Brome grass, rye grass, orchard grass, redtop and all other small-seeded grasses except bluegrass and canary grass are germinated on blotters, placed in small copper trays equipped with screens through which cotton wicks are drawn. The blotters are laid on the screens and are kept moist by the wicks. Seeds of peas, beans, and other vegetables to be examined for fungi are placed on blotters in large petri dishes about seven inches in diameter.

The pathogenic organisms which can be detected by these methods are Helminthosporium sativum on barley, wheat, oats, rye, and other grasses; Gibberella saubinetii and species of Fusarium on corn, barley, oats, rye, wheat, and many grasses; Fusarium spp. on peas and sorghum, Diplodia zeae, Nigrospora gallarum and Cephalosporium acremonium on corn, as well as many normally saprophytic species which are frequently present on many kinds of seeds.

Microscopic examination is frequently necessary in determining symptoms of various organisms; inoculation tests with pure cultures also aid in identification. Frequently germinating seeds are so overrun with saprophytic forms that accurate interpretation of the significance of certain pathogenic species is impossible.

6. Growing seedlings in soil or sand in the laboratory.

A valuable method which has been developed for determining the effect of certain organisms on the germination of barley, oats, rye, and wheat seed is that of planting the seeds in autoclaved soil (equal parts of screened sand and compost). Copper boxes 6" x 12" x 1½" inches are used as containers. The boxes are held at a temperature of 18 to 20°C until the seedlings are one or two inches high, after which they are placed on tables in the laboratory at a temperature of about 25°C. In 10 to 14 days after the time of planting, seedling blight is noticeable if Gibberella saubinetii or species of Fusarium are present on the seeds. Field tests have shown that the number of normal seedlings which appear in laboratory soil is closely correlated with field stand when conditions in the field are favorable for germination.

When the scab fungi are not present on a barley kernel it is possible to detect the symptoms of Helminthosporium sativum by the discoloration of the coleoptile and the young stem.

Both blotter and soil tests are considered necessary for the seeds of cereals to more correctly measure the presence and effect of blight organisms.

Clean builder's sand which passes a 16-mesh sieve, provides a satisfactory medium, if autoclaved, for testing seeds of peas, beans, soybeans, sorghum, onions, cabbage, and other vegetable crop seeds. Seed rots, stunting, dwarfing and seedling blights may be detected in sand and the results compared with those observed on blotters. Fusarium spp. are frequently found on the seeds of peas and sorghum and cause seed rot and poor germination of peas and seedling blight of sorghum.

7. Growing plants in greenhouse pots, benches and flats.

In some crops the agent responsible for the development of disease may not express itself until the host plant has attained considerable growth. In such cases a greenhouse is essential. Furthermore, a sample of seed may carry viroses or pathogenic fungi which will not be easily detected in the field because of unfavorable environment, hence, greenhouse tests under controlled conditions are necessary.

Helminthosporium gramineum which causes barley stripe can be detected most certainly in barley seed lots by a combination of laboratory and greenhouse methods. Johnson (7) has shown that temperatures of 10 to 12°C are most favorable for seedling infection, a fact verified by field tests. The method used in the Iowa Laboratory is to place at least 100 seeds on moist blotters in petri dishes at a temperature of 10 to 12°C. for 10 to 14 days, after which the seeds are transplanted to soil in greenhouse pots or benches. Within another 14 days the symptoms of stripe will appear if the organism was present in the seed lot.

Loose smut of oats develops well if the seed is planted in the greenhouse in January in a dry, cool soil. Within two months, readings for smut can be

made. The pathogens which cause loose smuts of barley and wheat can be detected in seed lots, by growing plants in the greenhouse until the heads appear.

Many other seed-borne pathogens, including those which cause black leg, black rot and yellows of cabbage, blight, anthracnose and mosaic of beans, leaf spot and pod blight of pea and the fusarial wilt organisms of flax, tomato and watermelon may be detected by growing plants in autoclaved soil or sand in the greenhouse under favorable environmental conditions for development.

Greenhouse tests for the determination of viroses in seed stocks are essential. The Iowa Laboratory has applied the technique developed by Henderson (6) for the detection of the yellow dwarf virus in onion bulbs and sets. In 1933 and 1934 over 200 seed lots were tested each year for the presence of yellow dwarf. Plantings were made in late September and readings completed in October. Growers were able to discard those lots with an appreciable amount of infection before planting time the following spring.

Limited greenhouse tests with potato seed stocks have been carried on for the detection of the viroses which cause spindle tuber, rugose mosaic and unmottled curly dwarf. Iowa potato growers purchase considerable quantities of certified seed stocks annually and the seed laboratory is enlarging its facilities and service to index seed stocks and compare the data obtained with yields in the field. Greenhouse indexing of tuber lots requires at least two houses, one with a low temperature and one at a moderately high temperature. At least one cutting from each tuber must be grown in each house.

8. Field tests for the appearance of diseases whose causal agents are transmitted by seed. Extensive field plantings have been made by the Iowa Laboratory staff using treated and untreated seeds of barley, corn, flax, oats, rye, wheat, sorghum, cabbage, beans, lima beans, soybeans, peas, sugar beets, garden beets, onions, sweet corn, carrots, spinach, egg plant, pepper, cucumber, cantaloupe, watermelon,and tomato. Field stand counts and percentage of diseased plants are determined and compared with laboratory tests. The appearance of certain diseases in the field plots is dependent on environmental conditions; hence tests must be made for several years with each crop to adequately correlate the presence of causal agent, as determined in the laboratory, with the appearance of the disease in the field. Data obtained from laboratory and field studies with barley, corn, flax, oats, and wheat from 1932 to 1937 are available in Research Bulletin 238 of the Iowa Agricultural Experimental Station.

Effect of Seed-Borne Organisms on Seed Germination

Organisms carried by seeds may be classified according to their effect on seed germination as noted on page 198. Those which cause injury to germination include a variety of organisms, the symptoms of which are as follows:

1. Seed rot - *Fusarium niveum* on watermelon, *Diplodia zeae* and *Nigrospora gallarum* on corn, *Fusarium* spp. and *Ascochyta pisi* on peas.
2. Damping-off - *Fusarium niveum* on watermelon seedlings.
3. Dwarfing and stunting - yellow dwarf of onion, mosaic of cantaloupe, *Fusarium conglutinans* on cabbage.
4. Etiolation - yellow dwarf of onion, yellow dwarf of potato.
5. Leaf spot - *Colletotrichum lindemuthianum* on beans, Colletotrichum lineola on sorghum, *Colletotrichum lagenarium* on cucumber and watermelon and *Bacterium lachrymans* on cucumber.
6. Leaf stripe - *Helminthosporium gramineum* on barley, *Bacterium translucens*

on barley.

7. Mildew - Sclerospora graminicola on corn and millet.

8. Necrotic lesions on stems and petioles, Phoma lingam on cabbage, Bacterium phaseoli on bean.

9. Root rot - Helminthosporium sativum on barley and other grasses.

10. Seedling blight - Gibberella saubinetii and Fusarium spp. on cereals, Diplodia zeae on corn.

11. Smut - Urocystis tritici on wheat and Urocystis cepulae on onion.

Effect of Environment on the Development of Disease

Reference has already been made to the fact that optimum conditions for seed germination and growth of the host plant may not be identical with those for the pathogen. Under such circumstances two tests may be necessary, namely, one to determine maximum viability of the seed, and one to detect the presence of and possible injury to be expected from the pathogen.

The need for both tests is evident when one considers that the mere presence of a pathogen in a seed lot may not necessarily result in loss from disease in the field. An illustration of this is barley stripe caused by Helminthosporium gramineum, an organism which may be present in a seed lot but will not develop appreciably unless the soil temperature is 15°C or less during the period of seed germination. Infected barley seeds planted late may show little or no signs of the stripe disease while the same seeds planted early may produce infected plants. Similarly, the seedling blight organism Gibberella saubinetii causes blight of wheat and corn at temperatures above the optimum for wheat and below the optimum for corn. The amount of moisture in the soil or substratum is also an important factor; for example, when barley is planted on blotters or in autoclaved soil, the maximum development of the organisms and of seedling blight takes place when a low moisture content and a temperature above 20°C are maintained.

III. Classification and Use of Seed Disinfectants, Methods of Application and Effect of Same on Seed Germination in Both Laboratory and Field.

The general use of seed disinfectants by a seed laboratory presupposes a knowledge of their function and place in disease control. The purpose for which seed disinfectants are designed and used by plant pathologists are as follows:

1. The control of systemic organisms which are entirely seed borne.

2. The control of non-systemic seed-borne organisms which cause seedling injury.

3. The protection of seeds and seedlings from soil organisms which cause seed rots, seedling blights and damping-off.

4. Improvement in field stand, yield and quality of crops. The use of seed disinfectants in seed laboratory research and practice is a new departure in seed testing (13) and,although the objectives may change as new information becomes available, it is believed that the following purposes are the major ones to be kept in mind by seed analysts:

1. Control parasitic organisms which cause injury to seed germination.

2. Control normally saprophytic organisms which make an interpretation of

seed germination somewhat difficult.

3. Surface-disinfect seeds and thus be able to determine internal parasites.

4. Correlate laboratory and field response of seeds to seed disinfectants and thus be able to index disinfectants as to their value in crop production.

5. Promote the practice of seed treatment and thus aid in a program of disease control.

An arbitrary classification of seed fungicides is difficult if not impossible, however, some basis of grouping is desirable. Possible bases are physical state and stability, depth of penetration, residual effect and toxicity. The following outline is presented as a convenient method of classification:

A. Physical State and Chemical Composition.

1. Liquids or solutions. In this class are included those fungicides which are normally liquids or which are disolved in water prior to their use. Representatives of this class are: (a) Formaldehyde; (b) Hydrogen peroxide; (c) Hot water; (d) Chlorine (e) Chlorox (f) Copper sulfate; (g) Mercuric chloride; (h) Uspulun and other organic mercury compounds.

2. Dry or dust fungicides. In this class may be included those compounds which are applied as finely ground dusts to seeds. In the presence of soil moisture, the toxic ingredients become active fungicides. Certain dust fungicides also volatilize. Members of this class may be subdivided according to the toxic agent which they contain as follows:

(a) Compounds containing formaldehyde, (1) Formafume (Volatile); (2) Smuttox (Volatile):

(b) Compounds containing mercury,

(1) Non-volatile, (a) Merko - 3.5% metallic mercury; (b) Bayer Dust; (c) Barbak - Mercuric cyanide; (d) Semesan - Hydroxymercurichlorophenol; (e) Semesan Bel; (f) Uspulun; (g) Sterocide; (h) Tillantin;

(2) Volatile, (a) Ethyl mercury phosphate including New Improved Ceresan and New Improved Semesan Jr., (b) Ethyl mercury chloride (2% Ceresan);

(c) Copper compounds, (1) Copper carbonate - 50 to 55% metallic copper, (2) Copper carbonate - 18 to 20% metallic copper, (3) Red oxide (Cuprocide, (4) Copper oxychloride;

(d) Zinc compounds, (1) Zinc oxide, (2) Vasco 4;

(e) Furfural compounds - Sterocide contains both mercury and a furfural derivative.

3. Gases or volatile compounds:

(a) Formaldehyde, including various dilutions of formalin, also formafume and smuttox.

(b) Organic mercuries, the most important of which are ethyl mercury and ethyl mercury phosphate.

B. Depth of Penetration. Fungicides vary in their ability to penetrate beyond the surface of the seed, hence they may be classified as surface and internal fungicides.

1. Surface sterilants - those which act mainly on surface-borne spores, mycelium, and bacteria. The more important representatives are: (a) Chlorine compounds; (b) Peroxide; (c) Copper compounds; (d) Mercuric chloride; (e) Organic mercury compounds except volatile forms.

2. Internal penetrants. Members of this group penetrate more or less beyond the outer layers of the seed and control certain internal organisms. The more important ones are: (a) Hot water; (b) Hot formaldehyde and hot mercuric chloride; (c) Acidulated mercuric chloride; (d) Formafume and smuttox; (e) Ethyl mercury compounds.

C. Residual effect. Certain fungicides are soon dissipated, others act slowly and afford protection to seeds for part or all of the germinating period. On this basis fungicides may be classed in two groups:

1. No important residual effect. Toxic agent soon dissipated: (a) Formaldehyde; (b) Formafume; (c) Smuttox; (d) Chlorine; (e) Peroxide; (f) Hot water.

2. Toxic ingredient slowly dissipated, affording protection to germinating seed and young seedlings: (a) Organic and inorganic mercury compounds; (b) Copper compounds; (c) Zinc compounds; (d) Aluminum compounds.

D. Toxicity. The ideal seed disinfectant is one which destroys the organism without injury to the seed embryo. Fungicides vary in their toxicity to specific organisms and to seed embryos. A necessary preliminary to the general use of seed disinfectants in a seed laboratory is to determine the relative susceptibility of both the host and parasite to the toxic agents in different compounds.

Hot water was used early in the history of plant pathology to control loose smuts of wheat and barley, each of which is caused by a seed-borne internal mycelium. It was soon discovered that extreme care in the use of hot water must be excercised because if the temperature were too low the pathogen was not killed and if it were too high the viability of the seed was destroyed. Even with the utmost care in practice, hot water treatment of cereals reduces seed viability and an increase in the rate of seeding is necessary.

Formaldehyde is another disinfectant which found early use in disease control and although it is highly toxic to many organisms, yet it too causes injury to seed viability either in strong concentrations or at high temperatures. Naked cereal seeds such as wheat, rye, hulless oats, hulless barley, and sorghum which have cracks or breaks in the pericarp are frequently injured even by dilutions as low as one part formalin to 320 parts of water. Hot formaldehyde, one part of formalin to 120 parts of water at a temperature above 52°F. is injurious to potato tubers if soaked longer than 5 or 10 minutes.

Copper sulfate solution, which found early use for the control of bunt of wheat, reduced the viability of the seed and thus necessitated the after treatment with calcium hydroxide to neutralize the copper sulfate.

Within the past 15 years there has been a marked shift from the use of liquid to dust disinfectants, although early attempts to use organic mercury compounds were largely with solutions. The superiority of dusts lies, first, in their ease of application and second, in their slow dissolution which affords protection during the period of seed germination and seedling development. Organic mercury compounds and the carbonates, oxides, and oxychlorides of copper have found most favor within the past 10 years as seed disinfectants. Zinc oxide and dusts containing formaldehyde have also received some attention. Derivatives of furfural have been shown by Reddy (15) to be of value in the control of seedling blights of corn.

The development and adoption of volatile mercury compounds for general use as seed fungicides has been rapid within the past few years. The chief disadvantage of these compounds is that they cause marked stunting and poisoning when used improperly or in excessive amounts. Seeds differ in their resistance and susceptibility to different concentrations of either ethyl mercury chloride or phosphate. The chief advantages of volatile mercuries are their toxicity to many seed-borne organisms, both internal and external, and their low cost. Both ethyl mercury chloride and phosphates are effective not only for practically all seed-borne smut fungi of cereals except those which cause loose smuts of wheat and barley but also for many partially seed-borne, systemic and non-systemic pathogens as well as soil-borne fungi that cause blights, damping off, seed rots and wilts of young seedlings. In addition they control saprophytic forms in laboratory tests.

Comparative tests with ethyl mercury phosphate, formafume, mercuric cyanide and copper oxychloride in the Iowa State College Seed Laboratory have shown that the ethyl mercury compounds are the only ones which successfully controlled seedlings blight of wheat and barley caused by Gibberella saubinetii and related species of Fusarium.

Use of Seed Disinfectants in Seed Laboratory Practice.

The application of the principle of seed disinfection to the routine of seed laboratory practice is dependent on the extent to which the effect of the treatment on germination in the laboratory is indicative of that in the field. It is our firm conviction that treatment of seeds in a seed laboratory test for a service report should be used only when the value of the treatment for field planting of the seeds in question has been determined or when the particular treatment is recommended for general use among farmers. Under such conditions a test should be made with both treated and untreated seeds, the results reported and an interpretation made as to the probable benefits to be derived from treatment.

It is necessary to exercise caution when reporting the presence of pathogens to laymen because one can never accurately predict field response. Leaflets and mimeographed sheets giving information about the disease in question and methods of control are necessary requirements for a seed laboratory that undertakes to detect and report the presence of seed-borne organisms.

If the above policy be followed, the need for extensive research becomes apparent. Many types of seed disinfectants may be used on different kinds of seeds in a preliminary way to determine which ones appear most valuable for further trial in both laboratory and field. Beginning in 1932, our laboratory initiated a study with organic mercury compounds, the specific objective being to compare the effect of treatments on seeds in the laboratory with that in the field. Later, other compounds were added including formafume, copper carbonate, copper oxychloride, red oxide of copper and mercuric cyanide.

Surface sterilants, such as peroxide and chlorox have also been used, the purpose being to determine their effectiveness for the control of the saprophytic forms frequently present on seeds. Five kinds of seeds were selected, namely, barley, corn, peas, sorghum, and soybeans. From each lot, 12 subsamples each with 200 seeds, were obtained and treated as follows:

1. Check - untreated.
2. Chlorox, one part to 9 parts distilled water.
3. Peroxide, one part to 9 parts distilled water.

4. Copper carbonate (50 to 55% metalic copper).
5. Copper oxychloride.
6. Cuprocide - red oxide of copper.
7. Ethyl mercury phosphate, 1%.
8. Ethyl mercury phosphate, 5%.
9. Merko - 3.5% mercury equivalent.
10. Semesan - hydroxymercurichlorophenal.
11. Talc.
12. Zinc oxide.

Chlorox and peroxide were used as solutions in which the seeds were soaked five minutes, dried and placed to germinate. All the other materials were applied as dusts. The excess dust was removed by shaking the seeds in a tea strainer.

Following the treatments, the seeds were placed on suitable substrata and at favorable temperatures for germination as follows:

Barley - top of moist blotters, 18 to 20°C.
Corn - top of moist blotters, 25 to 27°C.
Peas - rolled paper towels, 18 to 20°C.
Sorghum - between blotters, 20 to 30°C.
Soybeans - rolled paper towels, 20 to 30°C.

At three, seven and ten days after the tests were started, the seeds were examined and readings made for the number of seeds with growth of either parasitic or saprophytic forms or both. The data obtained after 10 days are shown in Table 2.

These data show that relatively few of the compounds prevented growth of fungi. Molds appeared earlier on the untreated seeds than on the treated ones. Apparently all the fungicides had acted as surface sterilants, some more effectively than others, but either internal organisms developed later or some spores and mycelia on the surface of the seed were not killed.

In general, the most effective fungicides were those which contained mercury, particularly ethyl mercury phosphate, although cuprocide and copper carbonate were fairly effective on barley, sorghum, and soybeans. The most striking result noted was that of ethyl mercury phosphate, Merko, Semesan, and copper carbonate on peas. The lot used showed about 15% infection with a species of Fusarium which was largely internal. The three mercury compounds and copper carbonate prevented external growth of the fungus on those seeds internally infected. A second point of interest is that the 5% ethyl mercury phosphate caused serious injury to barley, sorghum, and corn but only slight injury to peas and soybeans. Cuprocide seriously injured corn and the other copper compounds also caused considerable injury to corn.

The slight injury caused by the 1% ethyl mercury phosphate to peas and barley was undoubtedly caused by placing the seeds in towels and blotters immediately after treatment. Repeated trials have shown that the seeds should stand 24 hours after treatment before planting and that no injury in soil may be expected when only slight injury occurs in blotters or towels.

Comparison of Laboratory and Field Tests with Seed Disinfectants

Repeated trials since 1932 (13) have shown that the ethyl mercury compounds are toxic to more of the seed-borne fungi of barley, oats, and wheat than are other seed disinfectants and further that other organic mercury compounds are effective disinfectants for corn. More recent tests with cuprocide and copper

TABLE 2.

EFFECT OF DIFFERENT FUNGICIDES USED ON FIVE KINDS OF SEEDS FOR THE CONTROL OF SEED-BORNE FUNGI.

Treatment	Percentage of seeds showing fungous growths and injury from treatment														
	Barley			Corn			Peas			Sorghum			Soybeans		
	Moldy	Injured	Normal	Moldy	Injured	Normal	Moldy	Injured	Normal	Moldy	Injured	Normal	Moldy	Injured	Normal
Check	76		74	29		99	19		80	100		92	12		76
Chlorox	75	0	70	36	0	99	15	0	59	30	0	94	1	0	75
Peroxide	50	0	64	35	0	99	14	0	71	95	0	95	15	0	79
Copper carbonate	6	0	76	19	14	86	1	0	69	28	0	92	2	9	74
Copper oxy-chloride	9	0	75	18	14	84	15	0	70	77	0	92	--	81	81
Cuprocide	17	0	73	10	78	20	22	0	61	3	0	93	3	9	66
Ethyl M. phosphate 1%	7	0	**	14	0	**	9*	0	**	1	0	**	0	0	**
Ethyl M. phosphate 5%	0	100		0	100		0	97*		0	100		1	70*	
Merko	13	0	79	15	0	100	3	0	84	5	0	94	0	1	79
Semesan	4	0	45	17	0	98	2	0	88	21	0	93	0	0	77
Talc	19	0	79	30	0	100	15	0	67	100	0	91	0	0	80
Zinc oxide	18	0	72	16	0	98	16	0	72	20	0	90	5	0	72

*Injury only slight

**Not determined.

oxychloride show that for some crops field germination may be increased although Henderson bush lima beans have been seriously injured in field tests by copper oxychloride as shown in Table 3. The effect of ethyl mercury compounds on sorghum is shown in Table 4.

Data obtained with 129 lots of barley, four of lima beans, 154 of corn, 110 of oats, 18 of sorghum, and 21 of wheat justify the following conclusions:

1. The effect of seed disinfectants on seed germination in laboratory soil or sand and to some extent in blotters is reasonably indicative of what may be expected in the field.

2. Seedling blights of corn, small grains and sorghum and seed rots of peas and lima beans may be partially or completely controlled by proper seed treatment.

3. Ethyl mercury compounds of the proper strength are satisfactory disinfectants for barley, corn, lima beans, oats, sorghum and wheat both in the laboratory and in the field in that they not only control parasitic organisms but effectively check saprophytic forms which may make the interpretation of a laboratory test difficult.

4. Sand or a mixture of sand and soil, autoclaved at 15-pounds pressure, provides a laboratory medium superior to blotters for the germination of barley, lima beans, oats, peas, sorghum, and wheat and measures the effect of seed disinfectants on seed germination.

5. Dry treatments are preferable to liquids for both laboratory and field use because of (a) ease of application and subsequent seed storage, (b) ease of handling with vacuum or other seed counters, and (c) presence of a residue on seeds which affords protection from soil fungi.

6. The detection of seed-borne organisms as a part of routine seed analysis is facilitated by placing seeds on top of moist blotters with space between each seed to prevent rapid spread of fungi from infected to non-infected seeds.

7. Mercury poisoning is less liable to occur when seeds are germinated in sand or soil than in blotters or towels.

8. Seed laboratory reports which give the germination of treated and untreated seed are valuable aids in the establishment of seed treatment as an agricultural practice.

TABLE 3.

EFFECT OF SEED DISINFECTANTS ON FIELD GERMINATION AND YIELD OF LIMA BEANS - EMERGENCE AND NORMAL SEEDLINGS IN PERCENTAGE AND YIELD DATA IN POUNDS.

Sample	Check			Treatment No. 2			Treatment No. 3			Treatment No. 4		
	First count		Final	First count		Final	First count		Final	First count		Final
	Emer.	Germ.(1)	Germ.	Emer.	Germ.	Germ.	Emer.	Germ.	Germ.	Emer.	Germ.	Germ.
Plot 1												
Henderson A	81	75	81	82	79	81	80	73	79	17	15	23
" B	75	66	74	80	71	79	77	68	74	11	11	23
Fordhook X	80	76	81	83	81	85	80	73	82	87	83	90
" Y	84	78	86	87	83	87	89	84	90	89	88	88
Mean	80	74	81	83	79	83	82	75	81	50	49	56
Plot 2												
A	90	85	91	92	87	91	94	90	94	90	85	88
B	79	73	79	88	80	81	85	78	83	88	82	88
X	88	86	88	92	90	91	94	90	92	92	90	91
Y	88	87	88	91	88	90	93	92	92	96	92	95
Mean	86	83	87	91	86	88	92	88	90	92	87	91
Mean yield pounds per row												
Pods A			10.2			10.3			11.8			9.9
Shelled beans			2.4			2.7			2.7			2.5
Pods B			10.1			10.3			9.8			10.2
Shelled beans			2.0			2.0			2.1			2.0
Pods X			6.9			6.2			6.9			6.0
Pods Y			7.0			6.4			6.1			7.1
Treatments:												

Plot 1 - No. 2, cuprocide; No. 3, 0.5% Ethyl mercury phosphate; No. 4, copper oxychloride.

Plot 2 - No. 2, cuprocide; No. 3, 0.5% Ethyl mercury phosphate; No. 4, 1% Ethyl mercury phosphate.

(1) Germination means normal seedlings.

TABLE 4.

EFFECT OF ORGANIC MERCURY DUSTS ON LABORATORY AND FIELD GERMINATION OF SORGHUM. FINAL COUNT, JULY 1937.

Sample	Stand by treatments				Laboratory germination	
	1	2	3	4	Check	Treatment No. 2
Orange 1	73.0	80.8	79.5	74.8	89	90.5
2	51.5	47.7	58.3	52.0	79	75.0*
3	69.5	74.7	70.2	65.0	71.5	66.5*
4	23.3	31.7	31.2	36.0	79.0	79.5
5	55.8	66.0	62.8	47.0	40.5	46.0
6	60.5	66.2	64.5	72.2	91.0	91.5
7	57.5	60.8	65.5	60.8	77.5	68.0*
8	48.8	57.2	58.2	59.0	79.5	73.5*
9	80.8	81.5	81.5	78.2	91.5	91.0
10	53.8	74.2	56.5	59.0	69.5	62.0*
11	61.8	63.0	62.0	71.2	86.5	72.5*
12	62.8	71.0	69.8	65.8	87.5	89.0
13	94.2	90.8	95.5	92.8	99.0	95.0*
14	39.0	61.2	59.8	74.0	71.0	73.0
15	84.5	87.8	85.5	83.8	97.0	97.0
16	62.3	72.0	67.0	68.5	94.5	94.5
17	53.5	50.2	67.5	51.0		
18	22.0	25.0	41.0	45.0		
Totals	1054.6	1161.8	1176.3	1156.1		
Mean	58.6	64.5	65.4	64.2		

Treatments: 1 = Check
2 = 0.5% Ethyl mercury phosphate
3 = 1% " " "
4 = 2% " " chloride
* Mercury injury

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ABNORMALITIES IN THE GERMINATION OF LIMA BEANS

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The writer does not know how many of the seed testing laboratories are definitely interested in the problem of lima bean seed germination, but one thing is absolutely certain, if one has had any experience in handling these seeds in routine analysis, difficulties and variations in results have been encountered.

In the past seven or eight years workers in the New Jersey laboratory in the germination tests of lima beans, particularly the Fordhook variety, have observed abnormalities and peculiar tendencies in growth heretofore not so evident. The trade also has recognized these defects which they have attributed to degrees of ripening and thresher injuries, and handling at the time of and subsequent to harvest. Because New Jersey has a lima bean industry approximating a quarter or a third of a million dollars annually, it was apparent to us that some studies should be undertaken to determine the cause and extent of injuries (if such they be), and the subsequent evaluation and treatment of same. While other varieties than the Fordhook have been observed, the New Jersey laboratory has concentrated mainly on this variety, inasmuch as the metropolitan market favors this rather large plump bean, for which there has seemed to be no satisfactory varietal substitute.

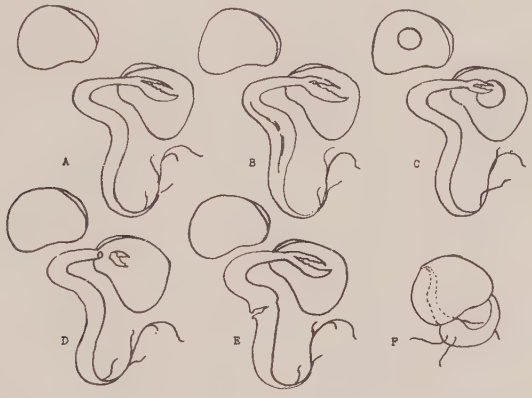
In examining any lot of Fordhook lima beans superficially, distinct external marks are quite prominent; such as dents, cracks in the coats which expose the cotyledons, and cracks which have to some extent healed over. These "marked" beans are the ones which we find produce more of the abnormal plants, although some seeds with no apparent outward blemishes have been known to produce abnormal growth.

The writer recalls some years ago (possibly at the Cleveland meeting of the Association) abnormal germination of lima beans was mentioned, and if the writer remembers correctly, seedlings in small boxes were exhibited. Since that time no direct evidence of further investigation on this subject has come to the writer's attention.

The problem seems as indicated, to have become more acute in recent years, and this fact has been substantiated by statements and conferences with the western growers. In comparing our tests in New Jersey, where several hundred are made yearly, with the original tests, and with those made by other laboratories and by growers, we found ourselves to be at variance from 10 to 15% in some cases. It seemed to us that these variations in careful analyses could not be attributed to error in technique or in personal judgment. Accordingly, we undertook a series of laboratory and correlated field trials to establish, if possible, the causes of variations in analytical figures. We are completing our third year of laboratory and field trials this year, and we feel that when we have completed this series of data we shall have determined some of the fundamental underlying factors. It is a pleasure to report to you that the investigations of Mrs. Drake and Mrs. Atwater of the Ransom Seed Laboratories in California working quite separately with the Henderson bush lima variety, have corroborated our results. While the two laboratories have given the abnormalities slightly different nomenclature, you will immediately recognize them as virtually

the same. Mrs. Drake will state in her paper the observation they have made on lima bean germination. In our work in New Jersey, the Department of Vegetable Gardening has closely cooperated, having recognized the difficulties inherent in this problem.

In the 1936 trials, five mechanical or diseased defects in seedlings were recognized which we felt should be investigated. The first were classified as, (a) those having wounded or broken roots; (b) those having brown streaks on the hypocotyl; (c) those having spotted or rotted cotyledons; (d) those with partially broken or completely severed plumules; and (e) those with bound or constricted roots. These were obviously in addition to the normal seedlings. Such developments are frequent, and one may say prevalent in almost any lot of lima beans, particularly Fordhooks, as they appear in the market today. These types of abnormal development are illustrated in Figure 1.



Character of abnormal developments at a six day germination, as observed in laboratory analyses

A - normal	D - broken plumules
B - lesions	E - wounded roots
C - spotted cotyledons	F - bound roots

Figure 1. - Types of Abnormal Development of Lima Beans.

We selected several lots of Fordhook lima beans and placed them in the regular medium in our germination chambers on May 28, 1936. Six days later we selected normal and abnormal seedlings of each of the above specified types, and transferred them to our test plots in the field, planting all seedlings six inches apart. These plots were given the proper fertilization and care which is essential to the development of a satisfactory crop. At regular intervals photographs and drawings were made of individual plants, and at the time of maturity total yields in pounds were determined. Types of pods, those containing one bean, two, three, and four beans were noted.

From the 1936 results we made certain definite observations, roughly, that the seedlings having broken or wounded roots seemed to recover somewhat in the field, that those with lesions produced variable results, that the majority of the plants with spotted cotyledons died, or if not the percentage of recoveries

was small, that the seedlings showing broken plumules were doubtful, and finally that the seedlings having bound roots tended to recover.

In 1937 we repeated our experiment with minor changes. The results of this work are given in Table 1. Our results with the transferred seedlings having

TABLE 1.
COMPARISON OF YIELDS OF LIMA BEANS PER 100 INDIVIDUALS PLANTED. ROWS OF 50 FEET LONG. RESULTS IN POUNDS. 1937 RESULTS.

	Type of abnormality				Normal	Seeds
	Lesions	Cotyledons spotted	Broken plumules	Bound by seed coats		
1st picking						
1 bean pods	0.06	0.16	0.22	0.12	0.28	0.19
2 bean pods	0.84	0.56	0.58	2.00	2.67	1.94
3 bean pods	1.36	0.96	0.96	3.80	4.27	2.87
4 bean pods	.66	-	0.18	1.64	2.27	1.12
Total	2.92	1.68	1.94	7.56	9.49	6.12
2nd picking						
1 bean pods	0.14	0.56	0.08	0.45	0.75	0.36
2 bean pods	0.40	0.84	0.44	1.96	2.59	1.64
3 bean pods	0.42	0.88	0.66	1.48	1.13	1.47
4 bean pods	1.60	0.32	0.42	0.40	0.16	0.67
Total	2.56	2.60	1.60	4.29	4.63	4.14
3rd picking						
1 bean pods	0.02	0.16	0.20	0.24	0.35	0.41
2 bean pods	0.20	0.16	0.74	0.49	0.62	0.80
3 bean pods	0.36	0.36	0.44	0.36	0.37	0.64
4 bean pods	0.10	0.16	0.16	0.12	0.02	0.18
Total	0.68	.84	1.54	1.21	1.36	2.03
Grand Total	6.16	5.12	5.08	13.06	15.48	12.29

wounded or broken roots made such marked recoveries in the field that we decided to eliminate them from our further trials. So in 1937 attention was concentrated upon seedlings having lesions, seedlings with spotted cotyledons, seedlings with broken plumules, and seedlings with bound roots or extra strong seed coats. From previous studies, however, it was observed that seedlings having lesions or brown streaks on the hypocotyl really occurred in two forms - a dry lesion or brown streak, and a wet lesion which apparently carries with it more serious complications. Separate plantings of these two forms indicate possible recovering in the case of the so-called dry lesions and usual non-development or destruction of the seedling in the case of the wet lesion. In the seedlings having broken plumules, which may develop baldheads, we also made definite observations, namely that we should recognize two classifications. First degree breaks in which secondary leaves may develop, and normal plants result; and second degree breaks in which

no leaves develop and true non-developing baldheads occur. These in no case recover sufficiently to produce normal plants.

Trials for 1938 have just been started. These we anticipate will show conclusively which of these abnormal seedling types may well under favorable conditions be expected to recover and develop. There are, however, a few additional facts which we hope to establish. This year mycological tests will be made of the spotted or rotted cotyledons, as well as the lesions, to determine what organisms are present, and if they can be responsible for the weakened vitality of the plants. Also, histological studies will be made of the hypocotyl of the seedling, and of the fully developed stem in an attempt to locate any abnormal vascular or other tissue development. It may be added that we have not overlooked the factor of nutrition in connection with these plants, and although perhaps it is not safe to definitely state our very preliminary findings at this time, we are inclined to believe that this factor may have a definite bearing on the development, normal or otherwise, of these plants. There were grown in the greenhouse this winter some flats of these seedlings deficient in certain essential elements, namely, magnesium, phosphorous, and calcium. A series of photographs (only one trial to be sure) showing plants with normal or complete nutritive elements, and those having deficiencies are presented. In this very superficial trial the abnormalities referred to in this paper are most evident. It is planned to continue this phase of the work to see if it has definite bearing. While it may be too early to speculate, it is entirely possible that deficiencies in these chemical elements in the soil where lima bean seed is grown may be more fundamental in the cause of these defects than some of the factors which have been superficially attributed to them.

Since the development of the seedling into a normal plant has been so strongly stressed, perhaps the reader may wonder why the writer has even considered this to be a problem vital to the analyst who is concerned, and who observes these conditions in a preliminary stage. The facts seem to warrant the writer's belief that we as analysts are not giving to the trade and the grower actual facts regarding the germination of lima beans, unless we take into consideration in our tests and reports the abnormal conditions herein described. Furthermore, the writer is convinced that we are making falsified statements when we give a total germination of a certain percentage on lima beans when these conditions exist. Therefore, the writer would like to recommend for your serious consideration, until research has established otherwise,a different and more detailed method of reporting lima bean seed germination. The writer would like to see in cases of lots carrying abnormalities which are herein described, a report as follows; namely a statement of the percentage of normal germination, together with percentages of broken plumules, spotted cotyledons, and lesions given separately, more or less as is done with hard seeds in legumes. It is believed that this matter is worthy of consideration by our committee on methods, and that careful thought should be given to it, and definite recommendations made.

OBSERVATIONS ON LIMA BEAN GERMINATION

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The evaluation of abnormalities occurring when germinating lima beans is one of the major problems in our California laboratory. In conducting germination tests, we have tried rolled towels, sawdust, various mixtures of soil, soil and peat moss, and sand. We find washed building sand to be the most satisfactory medium. The sand we use has been thoroughly dried in the sun and we have had very little trouble with fungous developments. The sand is easily secured and is porous and light to handle. We use redwood boxes, 9 by 9 inches and 2 inches deep, four of which fit nicely on a germinator tray. These are left in the germinators until the beans are above the sand, usually about four or five days, and then set in the light in the room for the remainder of the testing period. We have found that redwood, unlike other woods, is not a mould carrier. It makes a nice light weight porous container, affording good aeriation for root growth and is much cheaper than metal pans.

Last year we participated in a series of lima bean referee tests conducted by Dr. R. H. Porter. Our field and laboratory tests were supplemented by experimental and commercial field plots made by Wayne Metron of the McCrea Seed Company of Santa Barbara, California. The McCrea tests were carried out to the harvest and included the yields per bush on several hundred plants of each variety used. These plots were conducted under severe conditions and resulted in somewhat reduced yields. However, they afford a basis of comparison between abnormal and normal yields and are used as such in the following discussion of abnormalities. This year we conducted some more laboratory tests on Henderson Bush limas. These were transplanted into the field and compared with beans planted directly in the field, and were checked over a period of five weeks and the results tabulated. In addition, we secured pressed specimens to illustrate the periodic development of the different abnormalities. We have found that Henderson Bush and Fordhook limas are most subject to mechanical injury and have here classified their abnormalities together, though there is some varietal difference in the weaknesses.

CLASSIFICATION AND DISCUSSION OF ABNORMALITIES

For convenience we have classified abnormalities into nine general groups as follows:

BALDHEADS. There are two types of baldheads, one with the terminal growing point and primary leaves destroyed, and the other with the terminal growing point intact but with one or both primary leaves gone. The first we call a true baldhead and classify it as a worthless seedling. Our field plots show that in about two weeks the secondary buds at the bases of the cotyledons will develop and make a weak plant. These plants will survive through harvest, bearing a much reduced and late crop. Henderson Bush, normal plants, averaged 22 pods to the bush, and baldheads 9 pods. Fordhooks, normal plants, averaged 18 pods to the bush, and baldheads 9 pods. The second type of Baldhead we call Primary leaf injury and classify as a good sprout. The growing point is stimulated and develops as fast

as a normal plant so that in several weeks time the plant is as large as the normal plants. Henderson Bush, normal plants, averaged 22 pods to the bush and plants with primary leaf injury averaged 21 pods. Fordhooks with primary leaf injury averaged 18 pods to the bush as compared with 18 pods per normal plant.

BROKEN HYPOCOTYLS or KNEES. These are breaks in the hypocotyl and found particularly in the Henderson Bush limas. They vary from open wounds to healed breaks. Sometimes there are two or three at various points on a hypocotyl, and sometimes only one. There are often adventitious roots formed at the break. A great many of the knees do not seem to materially affect the vigor of young seedlings, except that they are more easily broken and the root system is somewhat reduced. The later development is somewhat impaired, due possibly to interference in the conductive system of the stem. The experimental field yields were considerably lower, averaging 9½ pods as against 22 pods for normal Henderson Bush plants. This difference was not quite so marked in the more favorable environment of the commercial field, being 25 pods as against 45 pods normal.

Some commercial samples have from 5 to 30% knees. It is easy to see that the presence of these weakened individuals would considerably reduce the total yield, even though they produced fair sized plants bearing beans. The interpretation of these lots of beans seems to be the fundamental cause of large variations in bean germination tests from different laboratories. It has been our experience that rolled towel tests or tests counted very early after emergence from the sand will not show this type of injury while the same samples after elongation of the hypocotyl, in field, greenhouse, or laboratory tests will show the abnormality clearly. Some laboratories count vigorous plants with knees as normal, some, as weak, and some as of no value at all. It is our opinion that they should be classified separately as weak plants capable of contributing towards the total crop under favorable cultural conditions, but incapable of producing a normal yield. This problem undoubtedly needs more study before a uniform standard can be adopted.

BOUND RADICLES. In these sprouts the radicle is slow in appearing and becomes dwarfed and curled. Often the roots show above ground first instead of the cotyledons. This is a fairly common trait of Fordhook limas, due possibly to their thick, tough seed coats. These curled sprouts did not emerge in heavy soil in the field, about half of them came up in light soil, and all eventually emerge in the laboratory. It is our practice in the laboratory to count as of no value any curled sprouts showing delayed emergence. The pressed specimens show that even those which survive have definitely dwarfed root systems.

LESIONS. Brown streaks on the hypocotyl. These seem superficial, perhaps caused by unfavorable moisture conditions, and do not affect the normal development of the plant. We classify these as normal.

ABNORMAL DEVELOPMENT OF COTYLEDONS. Sometimes Fordhooks develop three of four cotyledons causing an abnormal looking sprout. If the plumule is distorted and dwarfed we classify the plant as worthless but if the plumule is normal and vigorous we classify it as normal.

ABSENCE OF COTYLEDONS. We do not count as germinated a plant with both cotyledons gone. All trials showed definite dwarfing and the field tests yielded

only 3½ pods per bush. Plants with only one cotyledon are counted as normal. This condition is often accentuated by heavy soils in the field. These plants developed vigorously and yielded 19 pods per plant as compared with 22 pods per plant of Henderson Bush limas and 15 pods per plant compared with 18 pods per normal plant of Fordhooks. We evaluate cracked cotyledons according to the degree of injury, judging from the severeness of the break, and the general vigor and appearance of the plant.

GENERALLY WEAK. These plants are so spindly or injured that they have no possible field value. They are counted as worthless.

RADICLE INJURY. If the primary root is somewhat dwarfed or injured and strong secondary roots sent out, we count the plant as normal.

ROTTEN SPOTS ON COTYLEDONS. Fordhooks seem to be most susceptible to this condition. Under field conditions the fungous growth is arrested by light and air so that damage to the cotyledons is minimized. The plants develop normally. Rolled towel tests seem to facilitate the rapid spread of the fungous, and sand tests set out in the room, after the emergency of the plants, afford a much better environment than tests left in the dark, humid germinator. The plants in which the plumules are not affected by the rot, we count as normal. On the Fordhook field trials those with rotten spots on the cotyledons averaged 17 pods per plant as against 18 pods per plant for the normal ones.

There is still much difference between laboratories in the reporting of lima bean germination tests. It is needless to point out the confusion caused in the seed industry by such variations of opinion. The true field value of all abnormalities is of course largely determined by the cultural conditions under which they are grown. However, it is our observation that though the difference is less marked under ideal conditions, these abnormal plants still contribute less to the total yield that normal plants. We have read with interest the papers published in the News Letter by Miss Fiske and the Misses Everard and Thurliman and hope that the research committee will continue its efforts to arrive at an early standardization of interpretation.

HARD-SHELL SEEDS IN PEAS AND BEANS[1]

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Brief reports concerning various phases of hard-seededness in legumes have been presented from time to time before this Association. Peculiarly enough, alfalfa and clovers have been studied extensively while the large-seeded legumes have received but little attention. Gloyer (1)[2] in 1928 explained the various causes of hard-shell in beans and means of prevention. In a later publication (2), he listed 242 varieties of peas and 355 varieties of beans and showed the percentages of hard-shell occurring in each variety and selections from each variety. No direct reference was made to the significance of hard-shell in delaying the emergence of seedlings in the field and on the uneven maturation of the pods. Theophrastus (4) writing in the third century B.C., was aware of this relationship and stated: "However it is said to be a peculiarity of purse tassels that all the seeds do not germinate at once, but some in the first year, some the next year--beans (Vicia faba) in some places take as much as 15 days or even 20 (to germinate)".

Annual observations of 2,000 to 3,000 samples of peas has not, until recent years, indicated a commercially significant percentage of hard seeds in peas, although several of the unselected or ornamental varieties of beans have always exhibited hard-seededness. In 1937-38 seeds remained unswollen during the usual 6-day germination period in 87, or about 3.5% of the total, samples germinated. The percentages of hard seeds varied from 1 to 12. Strains of Wisconsin Early Sweet frequently contained 5% of unswollen seeds, and the majority of the hard-shell samples were of this variety. From 1 to 4% of unswollen seeds were found in 19 tests of Surprise peas. Other varieties containing hard seeds include Wyoming Wonder, Alderman, Canada Field, Green Admiral, Mammoth Melting, Rogers Chief, Rogers Ace, Telephone, Perfection, Horsford, and un-named selections developed by seed firms.

Varying numbers of unswollen seeds were observed in samples of garden beans and of Henderson lima beans. Only 2.6% of the former samples contained hard seeds, while nearly half of the latter did not germinate promptly. Other varieties of lima beans seemed not to contain hard seeds. Usually, the unswollen seeds were left in water-soaked towels until germination was complete. The time required for the last seeds to germinate was recorded and is shown in Table 1.

Several small bulk lots of Early Perfectah, Surprise, and Wisconsin Early Sweet seed were stored in a heated room for one year. The percentages of hard seeds after a 6-day test were determined both prior to, and at the termination of, the one-year storage. Contrary to expectations, there was no marked change in the occurrence of hard seeds in any variety. One lot of Early Perfectah contained 170 unswollen peas in a 1,000-seed test before the storage period and 163 seeds after storage. A large bulk lot of this strain of peas was held in an open shed. Repeated tests of 100 seeds each contained 15 to 19 unswollen seeds at periods of 1 month, 3 months, 12 months, and 16 months after initiation of storage.

Following the method outlined in a previous paper (3) seeds of the Early

[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 281.
[2] Numbers in parentheses refer to Literature Cited.

TABLE 1.
TIME REQUIRED FOR SEEDS OF VARIOUS VARIETIES OF BEANS, LIMA BEANS, AND PEAS TO SWELL - 200 SEEDS IN WET TOWELS AT 20°C.

Kind and Variety	Hard seeds at 6 days	Days to complete swelling	Kind and variety	Hard seeds at 6 days	Days to complete swelling
	%	Number		%	Number
Beans			Peas		
Asparagus	31	153 (1)	Surprise	3	15
Golden Wax	21	18	Do.	5	25
Do.	17	13	Do.	4	18
Do.	27	16	Do.	5	21
Do.	5	18	Mammoth M.	3	30
Do.	14	17	Surprise	2	16
Do.	13	17	W. Early Sweet	2	30
Do.	8	11	Do.	5	42
Kentucky Wonder	7	17	Surprise	5	89 (2)
Low's Champion	14	27	Do.	4	23
Do.	22	26	W. Early Sweet	12	32
Refugee	12	19	No. 111	9	37
Ruby Dwarf	20	11	Do.	3	23
Yellow Eye	7	14	No. 104	1	52
Otenashi	20	74	W. Early Sweet	4	46
			Horsford	3	45
Lima Beans			Surprise	12	16
			Surprise treated	15	29
Fordhook	4	26	Surprise	5	28
Henderson	17	43	W. Early Sweet	2	66
Henderson treated	12	36	Early Perfectah	21	178
Henderson	5	20	W. Early Sweet	13	41
Do.	19	82	Surprise	16	26
Do.	12	30			
Do.	7	39			
Do.	25	108			
Do.	6	28			
Do.	15	35			
Do.	12	30			
Do.	10	41			
Do.	10	26			

1. Twenty-two seeds remained unswollen.
2. One seed remained unswollen.

Perfectah, Surprise, and Wisconsin Early Sweet varieties were grown in the greenhouse during November and December of 1937. The percentage of unswollen seeds in preliminary 1-day soaking tests varied from 1 to 20. Each sample of unselected seeds was planted in lots of 25 seeds, replicated eight times. In two samples no seedlings emerged after nine days following planting, in eight samples emer-

gence was completed in 11 days, in four samples in 14 days, and in three samples emergence was not complete until the 19th day after planting. Lots of the same varieties which germinated promptly in the laboratory usually reached their maximum soil germination in 11 to 14 days.

Results from the seeds remaining hard after two days in water showed that the hard-shell condition was not of long duration in greenhouse soil. The maximum emergence of the samples was reached in 8, 11, 11, 11, 18, 21, 26, 28, and 28 days, respectively. The soil germination of the seeds which were immediately permeable to water was completed in 8, 11 and 11 days for the Surprise, Wisconsin Early Sweet and Early Perfectah varieties, respectively.

Since the interest of canners in hard-shell in peas deals mainly with the rapidity of emergence and the uniformity of maturation of pods, a number of selected samples were studied under normal field conditions. The hard seeds were secured by a 3-day soak in water. They were treated by shaking in a jar under three conditions; (a) no abrasive material, (b) cuprous oxide, and (c) sand. A few tests were made with hard seeds which had been clipped with a knife. The data are given in Table 2.

The root-rotting fungi complicated the results somewhat. Removal of a section of the seed coat by clipping, permitted ingress of the fungi with resultant decreases in germination. Cuprous oxide affected protection in part as is evidenced by the difference in number of the plants from the treated and untreated samples. The hard-shell condition appears to be beneficial in that it also protects the seeds against rotting.

The impermeable seed coats naturally inhibit the association of fungi with the cotyledons or sprouts when the seed coats become permeable to water. The germinating hard-shell seed is as susceptible to fungus attack as any promptly germinating seed would be in similar environment. This condition does not obtain, however, for many of the seeds do not swell until some time after planting and an entirely different, more favorable environment would then exist. The damping-off complex so little affects these late-germinating seeds that the final emergence of the hard-shell peas exceeds that of the early planted normal seeds. In No. 44,613 the untreated hard seeds averaged 75% final emergence from clay soil while the normal, unselected seeds averaged only 25% and the clipped hard seeds 3%. It is apparent that any treatment, either mechanical or chemical, which reduces the percentage of hard seeds should be accompanied by application of a chemical seed protectant.

The rows of 60-day-old peas from hard-shell seeds exhibited a definite lack of uniformity. Plants varied in development from the blossoming stage to mere sprouts. A considerable portion of the plants, probably all of those appearing after the 35-day-reading, could not possibly have any crop value. The vines from normal seeds were always more uniform. The use of sand or of cuprous oxide apparently affected neither the rapidity of germination nor the size of the plants.

A large bulk of the hard-shell strain of Early Perfectah peas was secured and several pounds of unswollen seeds were obtained by soaking the unselected peas in water for three days. The hard seeds were dried and treated in various ways in an attempt to secure prompt germination. These methods included abrasive treatments by hand or by a seed rotating machine, hand clipping, chemical corrosion, and moist and dry temperature extremes. Certain of the more interesting data are included in Table 3.

The sandpaper method consumed less time than any of the other hand treatments. The needle method was more rapid than either knife or scissors clipping but seemed

TABLE 2.

FIELD GERMINATION OF PEAS CONTAINING HARD SEEDS AND INFLUENCE OF VARIOUS TREATMENTS ON THE RAPIDITY OF EMERGENCE.

Lot No.	Number of seeds	Hard seeds %	Treatment	Number of seedlings emerged in days		
				20	35	50
Mixed 1	135	100	none	60	96	100(1)
Mixed 2	100	100	none	40	52	55
Mixed 2	58	100	Clipped with knife	9	11	12
Mixed 2	200	8	none	106	110	110(1)
Mixed 2	100	100	Shaken in copper oxide	67	75	76
Mixed 2	100	100	Shaken in jar	48	58	59
Mixed 2	100	100	Shaken in sand	45	53	54
Mixed 3	100	100	none	26	68	72
Mixed 3	59	100	Shaken in sand	13	36	36
Mixed 4	200	5	none	125	139	139(1)
Mixed 4	100	100	none	46	65	71
Mixed 4	95	100	Shaken in sand	46	57	60
10900	92	100	none	22	49	58
10900	100	100	none	42	73	80
10900	68	100	Shaken in jar	23	50	55
10900	100	100	Shaken in sand	46	61	67
44613	200	100	none	58	131	168(2)
44613	200	100	Shaken in jar	46	126	147(2)
44613	200	100	Shaken in copper oxide	31	119	151
44613	200	100	Shaken in sand	36	112	141
44613	200	100	Clipped with knife	7	10	10
44613	200	100	Clipped with knife	1	2	2
44613	300	100	none	17	139	204(2)
44613	200	16	none	36	46	46(1)
44613	200	16	Shaken in jar	37	51	51(1)
44613	200	16	Shaken in copper oxide	82	126	131(1)
44628	200	100	none	54	142	164
44628	200	5	none	114	142	142(1)
44628	100	100	Clipped with knife	40	57	57

1. Usually only hard seeds were planted but in a few rows normal unselected seeds were planted. These contained approximately the percentages of hard seeds as shown.

2. Sprouts appeared after the 50-day reading.

not as successful. The shaking methods, regardless of the abrasive material used, had but little effect on the seed coats. The chemical treatments were easily controlled and could be repeated at any time. Duplicate tests always gave nearly identical results. The final germinations proved that the seeds were not injured. The hot air and burning methods injured the seeds severely and did not increase the rapidity of swelling. It is interesting to note, however, that swelling is not a vital process since it occurred in any pea seed

TABLE 3.

EFFECT OF CERTAIN CHEMICAL, MECHANICAL AND HEAT TREATMENTS ON THE GERMINATION OF HARDSHELLED PEA SEED OF EARLY PERFECTAH VARIETY

Treatment	Total percentage of germination by days						Swollen seeds in 13 days or less
	3	5	7	9	11	13	%
Clipped with knife	62	96	98	98	98	98	100
Punctured with needle	35	80	96	96	97	97	99
Clipped with scissors	65	98	99	99	99	99	100
Rubbed over sandpaper	45	74	78	81	--	--	88 (1)
Burned on hotplate	9	13	19	19	--	--	94 (1)
Shaken 10 minutes	9	40	63	74	78	84	87
Shaken with sand	9	41	58	70	75	83	87
Shaken with copper	10	27	47	66	76	85	87
Shaken with glass	30	58	74	79	--	--	86 (1)
Shaken with brick lumps	29	55	75	81	--	--	87 (1)
Shaken with cinders	20	47	67	80	--	--	88 (1)
Shaken with gravel	23	58	72	79	--	--	90 (1)
Shaken with steel filings	46	40	56	73	--	--	78 (1)
Shaken with sandpaper	19	48	68	77	--	--	84 (1)
Water, 65°C. 20 minutes	35	66	79	87	90	91	96
Water, 65°C. 30 minutes	44	66	80	83	89	--	96 (2)
Water, 65°C. 40 minutes	37	73	82	83	85	87	96
Water, 65°C. 45 minutes	35	71	80	82	87	--	97 (2)
Water, 65°C. 60 minutes	34	65	68	71	75	--	98 (2)
Air, 130°C. 60 minutes	0	0	0	0	0	0	61
Water, 15°C. 3 hours	11	34	54	67	73	--	83 (2)
Air, 15°C. 5 hours	10	33	50	60	68	--	75 (2)
Air, 15°C. 24 hours	14	41	63	75	--	--	81 (1)
NaOH, 15 minutes (3)	19	49	63	72	81	--	81 (2)
NaOH, 30 minutes (3)	16	47	64	75	85	--	85 (2)
NaOH, 60 minutes (3)	14	46	64	72	87	--	87 (2)
H_2SO_4, 20 minutes (4)	16	58	83	91	94	96	98
H_2SO_4, 40 minutes (4)	45	90	98	98	99	99	100
H_2SO_4, 75 minutes (4)	55	98	99	99	99	99	100
No treatment	8	32	52	69	74	80	83
No treatment	15	30	44	59	68	76	81
No treatment	11	38	57	66	--	--	83 (1)

1. Swollen seeds after 9 days.
2. Swollen seeds after 11 days.
3. Twenty per cent sodium hydroxide, specific gravity of 1.22.
4. Concentrated sulfuric acid, specific gravity of 1.84.

that was permeable to water.

The unselected seeds germinated as promptly as did the punctured hard-shell seed but the final percentage was never as high. At least 6, and often 10%, of the swollen seeds rotted in the unselected-seed tests while never more than one decayed seed was observed in the punctured or chemically treated hard-shell selections. The peas which swelled in water within three days were also germinated. In a few tests the final germination reached 90%, but the average of several tests was only 84%. Undoubtedly, the hard-shell condition either protects the seeds against ageing or losses in hard-seededness and viability proceed at similar rates.

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GERMINATION REQUIREMENTS OF THE SEED OF SOME INTRODUCED AND NATIVE RANGE GRASSES

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Introduction

The recent interest in the use of native range plants and new introductions in the reclamation of land has brought to our laboratory the seeds of many grasses with which we have had no previous experience. In order to acquaint ourselves with the best method for the germination of this seed and also to furnish information as to the best season for planting, we have conducted research on the germination requirements of a number of species.

The quantity of material for testing was variable so that in some cases the results are only suggestive, but it is believed that the results obtained are of value as an indication of the germination requirements of such seed. More extensive investigations are in progress on other species.

Some references are found in the literature on germination studies with the seed of western range grasses, but a wide range of controlled germination conditions has not been tried by these workers. Wilson (6)[1] lists the average germination obtained on New Mexico range grasses tested by one method over a series of years. Jackson (4) studied the effect of two temperatures (25° and 35°C.) on the germination of a number of species. Rather low results were obtained with most species. Griswold (2) has reported on the effect of wetting and drying of the seed on the subsequent germination of several native range plants, but did not work with any of the species considered here. Blake (1) made an extensive study of the greenhouse and field behavior of many plants of the Great Plains region. In these papers it is difficult to determine whether the almost universal low germination obtained was due to the use of poorly filled seed or to lack of suitable germination conditions.

Material and Methods

In most cases only one sample of each of these species was available. The samples have been received at various times during the last three years from the Soil Conservation Service, the Division of Forage Crops and Diseases, Bureau of Plant Industry, and the Division of Range Research, Forest Service, United States Department of Agriculture. With many species the material received was as collected. An approximate purity separation was made and only florets that appeared to contain caryopses were used for germination.

The seed was placed to germinate on top of moistened paper toweling in petri dishes. The paper toweling was saturated with tap water or with a 0.2% solution of potassium nitrate. Experiments were conducted to test the effect of constant and alternating temperatures, prechilling, nitrate, and, in some cases, light. The alternation of temperatures was obtained by transferring the seed from one chamber to another, the seed remaining at the temperature listed first for 18 hours and at the other temperature for 6 hours, unless otherwise noted. In a few

[1] Numbers in parenthesis refer to Literature Cited.

cases, where a very high temperature was involved, the seed remained at the high temperature only three out of the 24 hours. In some cases, in order to expose the seed to light, the test was placed in a north window at approximately 20°C for a part of the alternation, designated by the letter "R." in the tabulations.

For the prechilled treatment, the seed was placed on moistened toweling in petri dishes as in the regular test and incubated at 3° to 5°C for certain definite periods.

The complete exclusion of light was obtained by placing the petri dishes in a tin box. The counts were made in a dark room with the aid of a blue light.

Duplicate tests of 100 seeds each were used at each temperature, except as indicated where it was impossible to obtain sufficient pure seed for this amount.

Experimental Results

FESTUCEAE

Poa macrantha Vasey., Seashore bluegrass, (sample 759555), a perennial, grows in sand dunes along the coast from Washington to Northern California. Only a small quantity of seed was available but from results obtained this Poa behaves like Poa compressa in that it is nitrate-sensitive. A germination of 98% was obtained with the use of potassium nitrate and 84% with the use of water at 20° to 30°C with light. We are not in a position to state the effect of light since there was not a check at the above temperature in complete darkness. Alternating temperatures of 20° to 35° and 15° to 25° and a constant temperature of 15° were not favorable for germination as 20° to 30° with light. A period of 21 days is sufficient for the germination of this seed at the most favorable temperature.

ERAGROSTIS spp.

The introduced species, Eragrostis curvula, E. lehmannia, E. abyssinica and E. brizantha, from South Africa, are included here with the native grasses since they are being tried out in western Soil Conservation Service plantings.

Eragrostis curvula (Schrad.) Nees. requires an alternation of temperature which includes a high temperature for maximum germination. As shown in Table 1, the alternating temperatures, Room to 35°C, 20° to 40°, and 25° to 40°, gave a germination of 94% or above in six days, with no sound seed remaining at the end of this time. The alternating temperature, 20° to 30°, with light gave almost as good results as the above alternations, but lowering the alternating temperatures below this point was detrimental. Complete germination was not obtained at any of the four constant temperatures tried: however, the germination increased as the temperature was raised from 10° to 25°. The seed was not sensitive to potassium nitrate except at temperatures unfavorable for complete germination. Prechilling was of no benefit.

Eragrostis lehmannia Pilger was sensitive to potassium nitrate. The constant temperature of 15°C seems to be the most favorable for the germination of this seed. A germination of 79% was obtained at this temperature with the use of potassium nitrate and 67% with the use of water. The remaining seeds of the nitrate test were softened and decayed so we consider 79% to be a complete germination of the viable seed. As the temperature was raised from 15° to 30°, in 5° steps, the percentage of germination was appreciably lowered. The alternating temperature, 20° to 30°, with light, gave higher results than the other alterna-

TABLE 1.

GERMINATION OF SEED OF ERAGROSTIS CURVULA

PURITY APPROXIMATELY 93%

SAMPLE NO. 272581

Time of germination count	Percentage germination at indicated temperatures with specified treatment																	
	10°C		15°C		20°C		25°C		15-25°C		with light 20-30°C		R.35°C		20-40°C		25-40°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(Days)																		
6	0	0	56	33	65	43	87	73	69	57	89	96	94	98	95	94	96	96
35	56	33	63	39	67	43	90	73	72	57	90	96						
	to		*	*	*	*	*	*	*	*								
35	20-40°C.																	
56	91	87																

	Prechilled at 3°C. to 5°C.							
	28 days				56 days			
	with light 20-30°C		R.35°C		20-30°C		R.35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
35	84	82	95	94				
63					88	85	87	94
	*	*			*	*		

* Test continued for 97 days with not more than 3% additional germination. Sound seed remaining at end of test.

TABLE 2.
GERMINATION OF SEED OF ERAGROSTIS LEHMANNIA
PURITY APPROXIMATELY 97%
SAMPLE NO. 272583

Time of germination count	Percentage germination at indicated temperatures with specified treatment																	
	10°C		15°C		20°C		25°C		30°C		15-25°C		with light 20-30°C		Room to 35°C			
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O		
(days)																		
14	0	0	79	62	51	13	15	16	8	11	45	25	80	45	34	27		
97	51	12	79	67	51	13	15	16	8	11	50	25	81	45	34	27		
	*	*		*	*	*	*	*	*	*	*	*		*	*	*		

Time of germination count	20-40°C		25-40°C		Prechilled at 3°C to 5°C							
					28 days to				56 days to			
					with light 20-30°C		25-40°C		with light 20-30°C		25-40°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
14	65	31	64	32								
35					82	56	65	13				
63					86	56			71	46	60	15
77									71	47	63	15
97	69	31	64	32			65	13			63	15
	*	*	*	*		*	*	*	*	*	*	*

* Sound seed remaining at end of test.

tions. When potassium nitrate was used, the results were practically the same at 20° to 30° and at 15°, but with water, the germination was about 20% lower at the alternating temperature. Prechilling the seed was of no benefit. The results are given in Table 2.

Eragrostis abyssinica (Jacq.) Link., an annual, appears to be nitrate sensitive. A germination of 94 to 97% was obtained with the use of potassium nitrate at alternating temperatures of 20° to 40°C, Room to 35°, and 20° to 30° with light, with no sound seed remaining at the end of the 14 days, (Table 3). This particular sample (No. 272746)showed no benefit of a prechilled treatment. A lower temperature alternation or constant temperatures were not tried.

Eragrostis brizantha, Nees. Of this species the lot (No. 272582) received in our laboratory had approximately 20% pure seed. Various alternating temperatures, prechilling the seed, and the effect of nitrate were tried. Since 5% was the highest percentage of germination obtained, with sound seed remaining at the end of 97 days, we do not consider the data worth mentioning except to point out that this seed has been found difficult to germinate.

Eragrostis secundiflora Presl. is a perennial growing in sandy soil from northern Florida to Kansas and New Mexico. This species shows a definite response to nitrate. Results obtained at the 20° to 40°C alternation were better than those obtained at Room to 35°. A prechilled treatment of 14 days was beneficial. The results are given in Table 4.

Eragrostis trichodes (Nutt) Nash. is a perennial of the sand barrens and open sandy woods from Illinois and Nebraska to Texas. This seed is nitrate-sensitive and responds to prechilling. A germination of 93% was obtained with potassium nitrate and 83% with water by prechilling for 14 days and then germinating at a Room to 35°C alternation. The results are given in Table 5.

AGROSTIDEAE

Polypogon monspeliensis (L.) Desf., Rabbitfoot grass, a common annual weed in the western states, requires an alternating temperature for complete germination. Germination of 83 to 95% was obtained at the seven alternating temperatures tried when potassium nitrate was used; with water, the results were much lower except at a high alternating temperature, (Table 6). Very poor results were obtained at the five constant temperatures tried and prechilling the seed at 3° to 5°C for 7 to 14 days was detrimental. The tests at the constant temperatures were transferred after 35 days to a high alternating temperature where they gave 90% germination or above. The tests formerly at a high constant temperature completed germination in 21 days and those formerly at 10° and 15° in 28 days. The seed is also light-sensitive. Higher results were obtained at 20° to 30° and Room to 35° with light than at 20° to 30° and 20° to 35° with little or no light. To a certain extent, the use of nitrate overcomes the lack of light. Tests conducted under light filtered through red or blue celophane gave approximately 90% germination under the red light and 10% under the blue light in seven days' time. These results are not given in tabular form.

Muhlenbergia racemosa (Michx) B. S. P., Marsh muhly, is a perennial found in moist meadows and low ground from Newfoundland and to British Columbia, south to Maryland, Kentucky, Oklahoma, and Arizona. This species is benefited by the use of potassium nitrate and a high temperature. As shown in Table 7, tests conducted at constant temperatures show an increased germination of approximately 60% as the temperature was raised from 10° to 35°C. The germination obtained at

TABLE 3.
GERMINATION OF SEED OF ERAGROSTIS ABYSSINICA PURITY
APPROXIMATELY 99% SAMPLE NO. 272746

Time of germination count (Days)	Percentage germination at indicated temperatures with specified treatment							
	20-40°C		R.35°C With light		20-30°C With light		Prechilled at 3°C to 5°C 14 days to Room to 35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
3	92	80	94	94	82	77		
7	97	84	94	95	96	95		
14	97	85	94	96	97	97		
17		85					93	81
21		85	94	96			95	85
42		85					95	85
		*						*

*Sound seed remaining

TABLE 4.
GERMINATION OF SEED OF ERAGROSTIS SECUNDIFLORA PURITY
APPROXIMATELY 50% SAMPLE NO. 272719

Time of germination count (Days)	Percentage germination at indicated temperatures with specified treatment					
	20-40°C		R.35°C		Prechilled at 5°C to 5°C 14 days to Room to 35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
5			67	52		
7	69	33				
14	87	48	76	56		
17					84	55
21	87	50	78	56	98	65
42	90	50	78	56	98	65
					*	

* No sound seed remaining

TABLE 5.
GERMINATION OF SEED OF ERAGROSTIS TRICHODES PURITY
APPROXIMATELY 99% SAMPLE NO. 272721

Time of germination count (Days)	Percentage germination at indicated temperatures with specified treatment							
	20-40°C		R.35°C		20-30°C With light		Prechilled at 3°C to 5°C 14 days to Room to 35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
5			38	9	34	15		
7	37	10			58	27		
14	56	15	62	13	64	30		
17							80	71
21	56	16	67	13	70	31	93	83
42	57	16	69	14	70	31	93 *	83

* No sound seed remaining at end of test.

35° is practically as high as that obtained at the most favorable alternating temperatures, 20° to 35° and 10° to 30°. Prechilling the seed was not beneficial. Fourteen days was a sufficient length of time for the duration of the test.

Muhlenbergia porteri Scribn., Bush muhly, is a perennial growing in dry places from western Texas to Colorado, Nevada, and southern California. The sample tested had an approximate purity of 8%. Only 100 seeds were used in each test. The alternating temperature, 20° to 35°C gave the highest results. The seed either germinated or decayed at this temperature. Low temperatures are detrimental to the germination of this seed. Low results were obtained at the alternating temperatures 10° to 30° and 10° to 35°, in which the seed was at 10° for 18 hours a day, whereas higher results were obtained when the seed was at 10° for only six hours a day (35° to 10°). The results are given in Table 8. The use of potassium nitrate was beneficial only at very unfavorable temperatures for germination. Prechilling had no effect on this seed. Maximum germination was obtained in seven days. Jackson (4) obtained variable results on this species at 25° and 35°.

Muhlenbergia rigens (Benth.) Hitchc., Deergrass, is a perennial of dry and open ground from Texas to southern California. The lot of this seed tested had an approximate purity of 53%. Only 100 seeds were used for each test. This seed germinated over a wide range of alternating temperatures (Table 9). The results indicate that a low temperature alternation (15° to 25°C), a very high temperature alternation (25° to 40°) or an alternating temperature involving a long period at the high temperature (35° to 10°), were not as favorable for germination as the alternations 20° to 30°, 20° to 35°, 10° to 35°, 15° to 35°, and 20° to 40°. At the favorable temperatures the seed either germinated or decayed. Prechilling at 3° to 5°, 10° or at 15° was not beneficial. At the constant temperatures the germination was increased as the temperature was raised in 5° steps from 10° to 35°. The results obtained with water were better in most cases than those obtained with potassium nitrate.

TABLE 6.
GERMINATION OF SEED OF POLYPOGON MONSPELIENSIS
SAMPLE NO. 757543

Time of germination count	Percentage germination at indicated temperatures with specified treatment															
	10°C		15°C		20°C		25°C		30°C		10-25°C		Room-10°C		15-25°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(Days)																
21	26	28	18	18	9	0	3	1	0	0	88	61	91	73	94	61
35	26	28	19	19	9	0	3	1	0	0	90	61	95	77	95	65
	*	*	*	*	*	*	*	*	*	*	*	*		*		*

	20-30°C		with light 20-30°C		20-35°C		R.35°C		Prechilled at 3° to 5°C			
									7 days to		14 days to	
									15-25°C	with light 20-30°C	15-25°C	with light 20-30°C
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	H_2O	H_2O	H_2O	H_2O
21	85	60	85	69	38	23	93	88	73	74	75	56
35	88	64	86	79	83	52	94	92	75	84	76	62
	*	*	*	*	*	*			*	*	*	*

* Sound seed remaining at end of test.

TABLE 7.
GERMINATION OF SEED OF MUHLENBERGIA RACEMOSA
SAMPLE NO. 757541

Time of germination count	Percentage germination at indicated temperatures with specified treatment															
	35-10°C		20-35°C		20-30°C		15-25°C		10-30°C		Room-35°C		Room-25°C		Room-10°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(Days)																
4	18	27	70	59	42	49	0	0	0	0	73	72	65	63	48	55
7	64	35	81	65	67	58	49	39	54	34	78	76	69	68	64	68
14	70	38	82	70	72	58	65	41	84	72	79	76	74	70	71	74
29	75	39	82	70	72	58	68	41	84	72	79	76	74	71	71	75
			*						*		*	*	*			*

	35°C		30°C		25°C		20°C		15°C		10°C		Prechilled at 3-5°C. 7 days to Room-35°C.		Prechilled at 3-5°C. 7 days to Room-10°C.	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
4	62	69	29	24	33	22	23	22	0	0	0	0				
7	68	70	30	26	37	23	26	23	20	6	0	0				
14	74	71	37	26	38	24	26	23	24	8	0	0	85	79	80	74
29	74	71	38	26	38	24	26	23	24	10	14	8	85	79	80	76
													*	*	*	*

* No sound seed remaining at end of test.

TABLE 8.
GERMIMINATION OF SEED OF MUHLENBERGIA PORTERI
APPROXIMATE PURITY 8%
SAMPLE NO. 760585

Time of germination count	Percentage germination at indicated temperatures with specified treatment																	
	25-40°C 6 hrs.		20-40°C 6 hrs.		20-40°C 3 hrs.		35-10°C		20-35°C		R.35°C		10-35°C		with light 20-30°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(days)																
3	46	51	10	20	36	40	26	40	34	45	49	55	0	0	12	19
7	73	75	55	54	79	77	61	66	83	83	76	76	2	0	70	71
14	74	76	57	58	79	77	66	70	83	83	76	76	17	2	74	71
21	74	77	57	60	79	77	69	70	83	83	76	76	22	3	74	71
	15-25°C		10-30°C		35°C		30°C		20°C		Prechilled at 3°C to 5°C 7 days to 20-35°C		Prechilled at 3°C to 5°C 14 days to 20-35°C			
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O		
3	3	7	0	0	65	59	64	76	29	20						
7	40	48	3	8	75	63	74	81	71	64						
14	54	56	30	17	75	63	74	81	72	69	72	67				
21	55	56	36	17	75	64	74	81	72	69	74	72	64	62		

TABLE 9.

GERMINATION OF SEED OF MUHLENBERGIA RIGENS

PURITY APPROXIMATELY 53%

SAMPLE NO. 767284

Time of germination count	Percentage germination at indicated temperatures with specified treatment															
	15-25°C		20-30°C With light		10-35°C		35-10°C		15-35°C		20-35°C		R.35°C		20-40°C		25-40°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(days)																		
21	64	48	66	69	62	68	34	45	68	72	60	70	65	75	50	71	27	59
28	64	50	66	69	63	69	34	45	68	72	60	70	65	75	50	71	27	59
42	64	51			63	69			68	72					50	71		

	Prechilled 10°C				Prechilled 15°C								Prechilled 3°C to 5°C					
	28 days to 20-35°C		42 days to 20-35°C		14 days to 20-35°C		42 days to 20-35°C		20°C		25°C		28 days to 20-35°C		42 days to 20-35°C		66 days to 20-35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3		KNO_3	H_2O
21	0	0	0	0	61	8	0	0	20	12	17	24						
28	0	0	0	0	61	80	0	0	20	12	17	24						
42	55	77	0	0	61	80	1	0	20	12	17	24	65	66				
56			72	72			55	71					65	66	65			
70																	61	67

	30°C		35°C	
	KNO_3	H_2O	KNO_3	H_2O
21	49	55	58	51
28	51	55	58	51
42	51	56		

CHLORIDEAE

Bouteloua spp.

The species of Bouteloua received were very low in purity. The seed is very difficult to clean because of the hairy rachilla: therefore, only 100 seeds were used in each test.

Bouteloua curtipendula (Michx) Torr., Side-oats grama, is a perennial of plains, prairies, and rocky hills. This species is benefited by the use of light but not by nitrate (Table 10). At Room to 35°C when light was excluded the seed gave over 10% lower germination than when light was not excluded. The use of potassium nitrate is detrimental at very high temperatures. The highest results were obtained at alternating temperatures of 20° to 30° with light, 10° to 35°, 10° to 30°, and 15° to 25°, and at the constant temperature 20°. All the viable seed appeared to have germinated at the above temperatures. Lower results were obtained at an alternating temperature of 25° to 40° in which the seed was at 40° for six hours than when the seed was at 40° for three hours. Although the 20° to 40° alternation does not show this difference for the 3 and 6-hour period at 40°, it shows over 10% lower results than the test at 20° to 30° with light. Comparing the 10° to 35° and 35° to 10° alternations, the longer period at 35° results in a much lower germination. This detrimental effect of high temperatures is also shown in comparing the 20°, 30° and 35° constant temperature tests: the 20° giving approximately 20% higher than the 35° test. Contrary to these results, Jackson (4) obtained high germination at 35°.

Bouteloua chondrosioides (H. B. K.) Benth. (sample 760689), a perennial, grows in the mesas and rocky hills in western Texas, southern Arizona and Mexico. Maximum germination (approximately 70% with potassium nitrate) was obtained at 25° to 40°C, and 20° to 35°. This species appears to differ in its behavior from B. curtipendula in that the high temperatures are not injurious and that it gave slightly lower results with water than with potassium nitrate.

Bouteloua filiformis (Fowen) Griffiths, Slender grama, grows on rocky hills from Texas to Arizona. This species showed a germination of approximately 50% in 21 days over a wide range of constant and alternating temperatures. It is not benefited by the use of potassium nitrate or light. The low germination was apparently due to immature seed since there were no sound seed remaining on the 56th day. The results are given in Table 11.

Bouteloua gracilis (H. B. K.) Lag., Blue grama, is a perennial of the eastern plains. A large lot of this seed (sample 760687) which proved to have an approximate purity of 3% was tested at a wide range of conditions. The alternating temperatures, 20° to 30°C and 15° to 25°, gave approximately 20% germination, the highest results obtained. Other samples, (samples 402047, 767686 and 767701) received in small lots, with approximate purities ranging from 20 to 30% have germinated from 60 to 75%. It appeared that all of the viable seed germinated. This species does not appear to be nitrate-sensitive.

Bouteloua eriopoda (Torr) Torr., Black grama, grows in dry, open places in Texas to southern Utah and northern Mexico. The highest results on two different samples (767699 and 767715) were 22% and 38%. These results were obtained at the alternating temperature, Room to 35°C with nitrate and appear to represent the full value of the samples.

Bouteloua perryi (Fowen) Griffith, Perry grama, (sample 760691) an annual of the mesas and rocky hills of Mexico and Arizona, and Bouteloua rothrockii

TABLE 10.

GERMINATION OF SEED OF BOUTELOUA CURTIPENDULA, SIDE-OATS GRAMA

PURITY APPROXIMATELY 49%

SAMPLE NO. 760592

Time of germination count	Percentage germination at indicated temperatures with specified treatment																	
	25-40°C 6 hrs.		25-40°C 3 hrs.		20-40°C 6 hrs.		20-40°C 3 hrs.		35-10°C		10-35°C		20-35°C		Room to 35°C			
															Light not Excluded		Light Excluded	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(days)																		
2	10	27	22	50	18	35	4	11	25	52	0	0	8	11	8	38	11	47
4	40	51	60	66	68	71	42	50	48	64	29	25	57	50	56	65	42	66
7	43	59	66	71	72	72	64	59	51	69	74	68	69	67	67	78		
14	43	61	68	80	72	75	72	71	52	71	84	78	71	72	67	79	56	73
21	43	62	68	80	72	75	72	72	53	71	85	79	71	74	67	80	56	73
28	43	62	68	80	72	75	72	72	53	71	85	82	73	74	67	80	56	73

	with light 20-30°C		10-30°C		15-25°C		20°C		30°C		35°C			Prechilled at 5°C. 7 days to 20-30°C D.L.		14 days	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O		KNO_3	H_2O	KNO_3	H_2O
2	0	0	0	0	0	0	0	0	48	64	50	46					
4	31	38	14	26	22	24	55	51	67	75	63	57					
7	84	81	64	62	69	64	69	69	69	78	65	58					
14	87	89	81	74	79	81	80	80	70	83	65	61		77	74		
21	87	89	82	77	80	82	81	82	70	83	65	61		80	80	78	80
28	87	89	82	78	80	83	81	83	70	83	65	61		81	80	83	82
35														81	80	85	82

TABLE 11.
GERMINATION OF SEED OF BOUTELOUA FILIFORMIS
PURITY APPROXIMATELY 59%
SAMPLE NO. 760590

Time of germination count	Percentage germination at indicated temperatures with specified treatment																	
	25-40°C 6 hrs.		25-40°C 3 hrs.		20-40°C 6 hrs.		20-40°C 3 hrs.		35-10°C		10-35°C		20-35°C		Room-35°C Light not excluded		Light excluded	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
(days)																		
2	46	34	31	40	21	21	14	5	37	41	0	3	12	15	26	28	29	28
4	58	46	48	53	45	49	50	39	61	56	49	41	50	50	55	53	53	49
7	58	47	49	54	49	50	53	47	62	57	58	45	52	55	56	55		
14	58	47	49	54	49	50	53	48	62	57	59	47	52	55	56	55	55	51
21	58	47	49	54	49	50	54	48	62	57	59	47	53	55	56	55	55	51
28	58	47	50	54	49	50	54	48	62	58	59	47	53	55			55	51

	With light 20-30°C		10-30°C		15-25°C		20°C		30°C		35°C		Prechilled at 3°C. to 5°C 7 days to 20-35°C		14 days		
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	
2	0	0	0	0	0	0	0	0	45	45	49	47					
4	38	37	41	33	31	12	48	36	58	48	56	55					
7	47	42	44	38	47	32	53	39	58	48	56	56					
14	51	45	50	40	56	35	56	42	59	48	56	56	56	54			
21	52	46	50	41	58	35	56	42	59	48	56	56	59	55	51	59	
28	52	46	50	41	58	35	56	42	59	48	56	56	59	55	51	59	

Vasey, Rothrock grama, (sample 760588) a perennial found in the mesas, canyons and rocky hills in Arizona and southern California, have proven very difficult to germinate. Germination was less than 5% on these species with many apparently sound seed remaining at the end of 35 days. These samples had an approximate purity of 62 and 42%, respectively.

Discussion

A full knowledge of the germination requirements of these species would need several years' experience with many samples tested after various periods following harvest. However, the results presented indicate a great variation in the requirements of the different species. There seems to be no tendency for the association of any germination requirement with a genus. For instance, Bouteloua filiformis was the least sensitive to conditions of germination while B. parryi and B. rothrockii have not germinated an appreciable amount at any of a wide range of conditions tried. Eragrostis brizantha has also been resistant to all attempts at germination. The germination of several other species of Bouteloua was low, but it is believed that with these the germination obtained expressed the full value of the sample since the remaining seed decayed.

In their response to temperatures, Eragrostis curvula, Polypogon monsepeliensis, Muhlenbergia porteri, M. racemosa, M. rigens, and Bouteloua eriopoda behaved somewhat alike in requiring a high temperature alternation. Of these M. racemosa and M. rigens appear to germinate well over the widest range of temperature alternations. Poa macrantha, and B. gracilis also require alternation of temperatures but over a lower range. Bouteloua curtipendula germinates equally well at the lower temperature alternations or at the constant temperature 20°C. Eragrostis lehmannia germinated best at a low constant temperature.

Of the species tested at a series of constant temperatures, Bouteloua curtipendula, Polypogon monspeliensis and Eragrostis lehmannia gave decreasing germination as the temperature was raised, while E. curvula, Muhlenbergia racemosa and M. rigens showed an increase of germination with increase of temperature. M. racemosa and M. porteri were the only species to germinate almost completely at a high constant temperature.

Eragrostis secundiflora and E. trichodes were the only two species benefited by prechilling, but from experience with Fescues (5) and freshly harvested cereals (3) we would expect no such effect except for varying periods following harvest. The age of the seed used in these studies was not definitely known, but the seed was at least two or three months old when received.

Polypogon monspeliensis and Bouteloua curtipendula were the only species definitely benefited by light.

Poa macrantha, Eragrostis lehmannia, E. abysinica, E. secundiflora, E. trichodes, Bouteloua chrondrosioides and B. eriopoda and Muhlenbergia racemosa were benefited by the use of nitrate whereas E. curvula and M. porteri were benefited by the use of nitrate only at temperatures unfavorable for complete germination. B. curtipendula showed a detrimental effect from the use of nitrate at temperatures too high for maximum germination.

The necessary time for completion of tests also varies with age of seed and other conditions, so that with little known species the test should be continued until the seed has germinated or decayed. In general, the species of Eragrostis, Muhlenbergia and Bouteloua germinated rather rapidly, the greater part of

the germination occurring in the first week, while the Poa and Polypogon species require three to four weeks.

Summary

Poa macrantha germinated best at an alternating temperature of 20° to 30°C with the use of potassium nitrate. Germination was complete in 21 days.

Eragrostis curvula required for maximum germination an alternation of temperature which includes a high temperature. The alternating temperatures Room to 35°C, 20° to 40°, and 25° to 40° gave a germination of 94% or above in six days.

Eragrostis lehmannia germinated best at 15°C constant with the use of potassium nitrate.

Eragrostis abyssinica is nitrate-sensitive. A germination of approximately 95% was obtained at high temperature alternations.

Eragrostis secundiflora and E. trichodes are nitrate-sensitive. The best results were obtained by prechilling for a period of 14 days before germinating at a Room to 35° alternation.

Polypogon monspeliensis is benefited by potassium nitrate and light. With water, the seed germinates well only at a high alternating temperature, but with the use of potassium nitrate the range of favorable alternating temperatures is widened.

Muhlenbergia racemosa germinated best at the alternating temperatures 20° to 35°C and 10° to 30° with the use of potassium nitrate. The constant temperature, 35°, gave almost as high results as the above alternating temperatures.

Muhlenbergia porteri germinated best at an alternating temperature of 20° to 35°C.

Muhlenbergia rigens gave about equal results at alternating temperatures of 20° to 30°C, 10° to 35°, 15° to 35°, 20° to 35° and 20° to 40°.

Bouteloua curtipendula germinated best at the cooler alternating temperatures, 20° to 30°C with light, 10° to 35°, 10° to 30° and 15° to 25°, and at the constant temperature, 20°. This species is light sensitive.

Bouteloua chrondrosioides germinated best at the alternating temperatures of 25° to 40°C and 20° to 35°, with the use of nitrate.

Bouteloua filiformis germinates over a wide range of alternating and constant temperatures. It is not benefited by the use of light or nitrate.

Bouteloua gracilis germinated best at alternating temperatures of 20° to 30°C and 15° to 25°.

Bouteloua eriopoda germinates best with the use of nitrate at an alternating temperature of Room to 35°C.

Bouteloua parryi, B. rothrockii, and Eragrostis brizantha germinated 5% or less under various conditions tried.[1]

Of the species tested at a series of constant temperatures, Bouteloua curtipendula, Polypogon monspeliensis, and Eragrostis lehmannia gave decreasing germination as the temperature was raised, while E. curvula, Muhlenbergia racemosa and M. rigens showed an increase of germination with increase of temperatures.

[1] Subsequent work with pretreatment of the seed of Eragrostis brizantha with approximately 71 percent sulphuric acid resulted in approximately 55 percent germination for treatments of 5 to 9 minutes when germinated at 20° to 40° C, room to 35° or 20° to 30° with light. Similar treatment of the seed of Bouteloua parryi and B. rothrockii was not beneficial.

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LABORATORY GERMINATION STUDIES WITH AGROPYRON SMITHII - PRELIMINARY RESULTS[1]

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The emphasis given to range reseeding and other soil conservation practices during recent years has brough several species of native grasses into commercial prominence. One of the most important of these is Agropyron smithii (Western Wheat Grass).

As each new species comes into commercial use, the analyst must determine the most satisfactory methods of making germination tests. The purpose of this paper is to briefly report the results secured from various methods of testing Agropyron smithii at the Montana seed laboratory.

Methods of Testing and Results

Four lots of Agropyron smithii from the 1935 crop, six lots from the 1936 crop, and 23 lots from the 1937 crop were secured.

All tests were run for a period of 60 days with preliminary counts at approximately 14, 30, and 40 days. On the average, approximately 86% of the germination took place within 30 days, 98% within 40 days, and 2% after 40 days.

1935 crop - The lots from the 1935 crop were tested by three methods.

1. Between blotters at alternating temperatures of 20°C for 18 hours and 30° for 6 hours.
2. Between blotters at alternating temperatures of 20°C for 18 hours and 35° for 6 hours.
3. On top of blotters in light germinator at alternating temperatures of 23°C for 18 hours and 30° for 6 hours.

Tests in the light germinator gave inferior results in comparison with the other two methods. The average germination of the tests at 20° to 30° was 83%, while that at 20° to 35° was 77%. This indicates an advantage in favor of the tests at 20° to 30°. However, when the standard error was calculated and the tests for significance applied, this difference was not important.

1936 crop - Seed from the 1936 crop was tested by the 20° to 30° method already described and also by transferring the seed to new blotters daily, with temperatures at 20° to 30°. The average germination by both of these methods was 89%. Since daily changes of substrata proved of no advantage, this method of testing was discontinued.

1937 Crop - Five methods were used in testing the seed from the 1937 crop.

1. Between blotters at 20°C for 18 hours and 30°for 6 hours.
2. Between paper towels at 20°C for 18 hours and 30° for 6 hours.
3. Between blotters prechilled for 6 days at 8° - 10°, completed at 20° to 30°.
4. In soil of half sand, half loam at 14° - 17°C for 6 days, completed at 20° to 30°.
5. In soil half sand and half loam at alternating temperatures of 20°C for

[1] Contribution from the Montana State College, Agricultural Experiment Station. Paper No. 115, Journal Series.

18 hours and 30° for 6 hours.

The tests begun at 8°-10°C and 14°-17°C gave inferior results and were discontinued after five lots had been tested. The average germinations by the other three methods were: between blotters, 72%; between paper towels, 72%; and in soil, 85%. The results of the tests in soil were equal to or better than the results by the other methods in every determination. When the results in soil were compared with those secured between blotters, the standard error was 1.61 while with those between paper towels it was 1.72. Both these values were found to be highly significant.

Satisfactory germination results were difficult to obtain from certain lots of seed. With such lots the advantages of the soil test were usually pronounced.

Summary and Conclusions

Seed of Agropyron smithii from the 1935, 1936, and 1937 crops was tested for germination by different methods.

Germination tests in soil at alternating temperatures of 20°C for 18 hours and 30° for 6 hours gave significantly higher results than those secured from tests by any other method used.

Approximately 86% of the germination took place within the first 30 days, while the average germination after 40 days was but 2%.

MOISTENING AND DRYING AS A PRETREATMENT IN GERMINATING SEEDS OF POA COMPRESSA

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A part of the results obtained in the investigation on the effect of daily moistening and drying of seeds of Poa compressa prior to germination[1] was presented before the Physiological section of the Botanical Society of America at Indianapolis, Indiana, December, 1937. The writer, thinking this method might have a practical value in seed testing, wishes to present some of the details of the procedure and germination results, including recent work, before this meeting of Seed Analysts.

In this experiment, seeds were sown in Petri dishes, with lids removed, on several thicknesses of filter paper moistened with water and left exposed in the laboratory. The filter paper was moistened with water each morning and was usually completely dry the following morning. This treatment was also carried out under controlled temperature conditions, but with no more beneficial effect, and under some conditions less beneficial than in the uncontrolled temperature of the laboratory. Therefore, for clarity the germination results of the daily moistening and drying in the uncontrolled temperature of the laboratory only will be presented here.

After one, two, three, and four weeks of moistening and drying, the Petri dishes were covered and placed to germinate, with daily alternations, in the north window of the laboratory at approximately 20°C for 18 hours, and 30°C for six hours during a period of 28 days. Seeds daily moistened and dried for two, three, and four weeks, respectively, gave about 90% germination, which is comparable to the untreated controls moistened with dilute nitrate solution. The controls moistened with water gave approximately 60 to 70% germination. Seeds treated for one week gave slightly lower results than the longer treatments.

In another series, conducted in the same manner except that the seeds were placed to germinate daily in a daylight germinator at 30°C for 6 hours and a dark chamber at 20° for 18 hours, practically similar germination results were obtained, and comparable to the controls moistened with dilute nitrate solution. The controls moistened with water gave about 50% germination.

In a third series, conducted in the same manner, except the seeds were placed to germinate in darkness, the highest percentage of germination (approximately 85%) was obtained with seeds daily moistened and dried for three or four weeks, which is comparable to the controls moistened with dilute nitrate solution, also germinated in the dark. Controls moistened with water gave about 35% germination.

In general, three weeks and usually two weeks of daily moistening and drying of the seed prior to germination in room- 20-30°C or daylight-30-20° temperature gives a high percentage of germination of the viable seed, which is comparable to the germination of seeds in which dilute nitrate solution is used to moisten the filter paper and higher than when water is used. This method is perhaps somewhat similar to what happens when we sow seeds out of doors and has the advantage of not having any chemicals as used in our present routine method.

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[1] Abstract, American Journal of Botany, Vol. 24, 1937;
Abstract, Herbage Abstracts, Vol. 8, No. 1, 1938.

CANADA BLUEGRASS SEED IS SENSITIVE TO GERMINATIVE CONDITIONS

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It has long been recognized that potassium nitrate solution is beneficial in promoting germination of Poa compressa seed and definite suggestions for its use are incorporated in the Rules for Seed Testing. In spite of this, however, complaints, calling attention to wide differences in germination figures, are still received at the laboratory. The writer's immediate objective, then, is to emphasize what appears to be the most satisfactory method for germinating the average sample of Canada bluegrass seed.

Practically all samples of this species received during the spring of 1938 were decidedly responsive to the use of potassium nitrate solution. The average increase in germination obtained by the use of 0.2% KNO_3 solution was about 60%. Four of these most sensitive seed stocks were subjected to additional tests, using 4 x 100 seeds in each case. The methods used and the average germination obtained from each are shown in Table 1. The tests were continued through the usual 28 days, but in each instance the maximum germination had apparently been attained by the 23rd day.

TABLE 1.
SUMMARY OF METHODS USED AND RESULTS OBTAINED WITH THE GERMINATION TESTS OF CANADA BLUEGRASS

	Methods Employed	Seed stock and germination			
		8081	10528	10609	10693
		%			
	Absorbent cotton moistened with:				
1.	Tap water	20	15	30	12
2.	Distilled water	11	33	38	15
3.	0.1% KNO_3 solution using distilled water	67	60	73	78
4.	0.2% KNO_3 solution using distilled water	76	76	81	68
5.	0.2% KNO_3 solution using tap water	78	76	81	71
6.	0.3% KNO_3 solution using distilled water	76	88	77	66
7.	0.5% KNO_3 solution using distilled water	78	80	83	69
8.	1.0% KNO_3 solution using distilled water	18	22	10	12
	Sand moistened with:				
9.	Tap water	31	28	45	--
10.	Distilled water	24	17	43	--
11.	0.2% KNO_3 solution using tap water	59	55	80	--
12.	0.2% solution using distilled water	67	51	63	--
	After drying for 24 hours at 40°C:				
13.	Cotton and tap water	16	10	25	25
14.	Cotton and 0.2% KNO_3 using distilled water	64	61	80	70
	Original germination 3 mos. previous:				
15.	Cotton and tap water	22	21	26	26
16.	Cotton and 0.2% KNO_3 using distilled water	90	90	85	92

[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 280.

From the results it is interesting to note that three of the four samples tested had decreased in viability during the three months which elapsed since the original tests were made. This decrease was accentuated in those tests in which KNO_3 solution was applied. We may conclude, therefore, that as the seed increases in age the stimulatory effect of the KNO_3 becomes less pronounced.

The use of cotton as a substratum and tap water as the source of moisture gave consistently low figures, while distilled water, in most cases, gave slightly higher germination. Tap water may have a retarding effect due to the concentration of the Ca^{++} ion, as suggested by Borthwick for the retardation in the germination of Hypericum perforatum seeds, since the water in this instance is highly alkaline. The use of sand as a substratum appears to give higher results when moistened with tap water than when distilled water is used. Minerals present in the tap water apparantly become beneficially available in combination with the sand, whereas they are lacking from the distilled water. Germination figures obtained by using KNO_3 crystals dissolved in tap water and in distilled water are entirely comparable. The KNO_3 appears to be not only antagonistic to the Ca^{++} ion but changes the ionic concentration of the tap water, which alone may also have a retarding effect.

The use of sterilized sand as a substratum with tap water was somewhat better than cotton, while the stimulatory action of the KNO_3 solution seems to be somewhat dissipated when used in conjunction with sand.

In their response to different concentrations of KNO_3 solution individual samples seem to vary considerably. Concentrations of 0.1, 0.2, 0.3, 0.5, and 1.0% were used. KNO_3 acts as a stimulant and accelerates the growth of molds and fungi; concentrations greater than 0.2% tend to promote damping-off of the seedlings. Dead, moldy seeds will stand out more visibly when the higher concentrations are used, however. With a concentration of 1.0%, damping-off is not only markedly increased but germination is decidedly inhibited, the seedlings being weak, abnormal and retarded.

Subjecting the test samples to a drying temperature of 40°C for 24 hours, did not markedly affect their ultimate germination. This is in accordance with what might be expected as Harrington found that Kentucky bluegrass seed could be desiccated to 0.1% moisture without affecting germination, although the vigor of the seedlings was greatly reduced.

Except for the occasional and unusual individual sample Canada bluegrass seed can probably be germinated most satisfactorily on cotton moistened with a 0.2% KNO_3 solution made by dissolving the KNO_3 crystals in distilled water. The cotton used should be of the absorbant type and need consist of only one layer approximately 3/16 of an inch in thickness. This can easily be cut to fit into petri dishes. The KNO_3 solution can then be poured onto the cotton. When the cotton has been thoroughly wetted, the excess solution can be forced out with slight pressure of the fingers and drained away.

These results substantiate previous findings, by Toole and others, and show the great necessity of using specific procedures when testing the viability of this kind of seed. Failure to do so may lead to wide variations in results between laboratories or seed sources.

THE GERMINATION OF THE SEED OF ALSINE MEDIA

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Plants of Alsine media (L.) Cyrill, common checkweed, a common annual weed introduced from Europe, were collected May 9, 1936, in a garden near Washington, D. C. The mature seeds which were shaken from the fruiting heads, were used for a study of the effect of various temperatures, of potassium nitrate, and of light on germination. One hundred seeds were placed in each petri dish upon five layers of paper towelling moistened with tap water or 0.2% solution of potassium nitrate and placed to germinate under various conditions as indicated in Tables 1, 2, and 3.

It will be noted in Table 1 that when the seed was first tested on June 30, there was little germination in a period of 14 days except with the test at 20° to 30°C alternation with light and on which potassium nitrate was used. However, on October 30, at all temperatures, with the exception of constant 25° and 30°, maximum germination was obtained with potassium nitrate while the germination with tap water had increased from an average of 7% in June to an average of 33.7% in October. The germination of approximately 85% obtained with potassium nitrate at favorable temperatures is believed to represent the average viable seed, since under these conditions all seeds either germinated or decayed. In May 1938, after nearly two years, the seed does not germinate as well at the extreme temperatures as in October 1936. This change is most marked when potassium nitrate was not used.

Because of the apparent effect of light on the June 1936 test, seeds were exposed on August 5, 1936 to light for a series of from one to six hours and placed in the dark at various temperatures. The resulting germination (not given in tabular form) in a period of 14 days was approximately 80% with nitrate and 17% with water for both treated and untreated seed.

To study the comparative effects of nitrate and light, comparison was made by germinating the seed at 20° to 30°C alternation with light and also under the same conditions except that the dishes were enclosed in a tin box to exclude light. Counts of the lightless tests were made in a dark room with the aid of blue light. With the seed moistened with potassium nitrate (Table 2), light had considerable effect on both rate and total germination on the first date tested, while on the succeeding tests light had no effect on either rate or total germination. Light had no effect on the seeds moistened with tap water; since, in the June test at the end of 49 days, light gave 6% germination and dark, 10%, while in the October 30 test each germinated 44%. In the May 1938 test, there was also no difference between germination in light and in dark, when water was used.

In all the tests from June 1936 through May 1938, there was no germination at 30°C and very low germination at 25° as shown in Table 3. Neither the use of light nor of potassium nitrate caused germination until the tests had been transferred to a lower temperature. However, as with the tests at other temperatures showing incomplete germination, change of temperature gave only a slight increase unless accompanied by potassium nitrate. The addition of potassium nitrate and lowering the temperature failed to give complete germination of the June test started at 30° with water, hinting at the development of secondary dormancy at

TABLE 1.
GERMINATION OF SEED OF ALSINE MEDIA AT VARIOUS TEMPERATURES IN 14 DAYS.

Date of germination test	Percentage germination at indicated temperatures with specified treatment															
	10°C		15°C		20°C		25°C		30°C		15°-25°C		With light 20°-30°C		20°-35°C	
	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O	KNO_3	H_2O
June 30, 1936	-	5	-	-	-	9	-	0	-	0	-	10	64	4	-	-
Oct. 30, 1936	85	40	79	34	79	23	44	10	0	0	77	33	84	42	84	29
May 10, 1938	65	8	-	-	89	22	19	1	0	0	82	26	90	30	80	5

TABLE 2.
RATE OF GERMINATION OF SEED OF ALSINE MEDIA WITH AND WITHOUT LIGHT AT 20° to 30°C.

Time of germination count	Progressive percentage germination with specified treatment at three different dates											
	With light						Without light					
	With potassium nitrate			With water			With potassium nitrate			With water		
	June 30, 1936	Oct. 30, 1936	May 10, 1938	June 30, 1936	Oct. 30, 1936	May 10, 1938	June 30, 1936	Oct. 30, 1936	May 10, 1938	June 30, 1936	Oct. 30, 1936	May 10, 1938
(Days)												
4	0	80	71	0	41	22	0	74	38	0	43	13
7	60	81	89	5	41	30	17	77	87	5	43	27
14	64	84	90	5	42	30	17	77	89	5	44	28
21	70		90	5	42	30	18		89	6	44	28
28	72		90	5	42	30	18		89	10	44	28
35	77		90	6	42	30	19		89	10	44	28
49	78			6	44		24			10	44	

TABLE 3.
GERMINATION OF SEED OF ALSINE MEDIA AT TWO CONSTANT TEMPERATURES WITH SPECIFIED TREATMENT. RESULTS IN PERCENTAGE.

Days	June 30, 1936		October 30, 1936				May 10, 1938			
	25°C	30°C	25°C		30°C		25°C		30°C	
	Water	Water	KNO_3	Water	KNO_3	Water	KNO_3	Water	KNO_3	Water
4	0	0	37	9	0	0	11	1	0	0
7	0	0	41	10	0	0	19	1	0	0
14	0	0	44	10	0	0	19	1	0	0
35	3 (1)	0 (1)	44	10 (1)	0	0	19	1 (1)	0	0
49	3 (2)	0 (2)	46 (2)	10 (2)	0 (2)	0 (2)				
66	85	19	83	55	75	11				
80		30 (3)	83	55	75	11				
92			86	55 (4)	76	11				
99				69		11				
110				83		11 (3)				

1. Potassium nitrate added after 35th day.
2. All tests transferred to 10°C after 49th day.
3. Sound seed remaining at end of test.
4. Transferred to 20° to 30°C after 92nd day.

this high temperature.

Surveying at a glance the effects of temperature, light, and nitrate, probably the most outstanding points are the change in germination response with the progress of time and the marked effect of potassium nitrate at all times. Between June 30th and August 5th, the response to light disappeared; by October the rate of germination with potassium nitrate had increased to give maximum germination in 14 instead of 49 days, and with water, the rate and total germination increased slowly, but complete germination of the viable seeds was not obtained. Lehmann[1] in studying the effectiveness of Knop's nutrient solution as a stimulant of germination, found that seeds of Alsine media were strongly influenced by a 1% solution, although this seed was not considered to be stimulated by light. Contrary to what might be expected, the germination with water did not increase between October 1936 and May 1938. In fact, the seed appeared to germinate less readily at extreme temperatures after two years' storage. Age of the seed had the least effect upon germination at the constant temperatures 25°C and 30° as this seed is especially sensitive to high germination temperatures at all times.

Summary

A dilute solution of potassium nitrate stimulated germination markedly, both with fresh and with older seed.

Light seemed to stimulate the germination of fresh seed (tested approximately two months after collection), but the effect had disappeared a month later.

Fresh seed germinated very slowly with potassium nitrate and light and very little with water, with or without light.

[1] Lehmann, Ernst. Zur Keimungs physiologie und Biologie von Ranunculus sceleratus L. und einigen anderen Samen. Berichte der Deutschen Botanischen Gesellschaft. 1909.

Four months later, germination was essentially the same at 10°C, 15°, 20°, 15° to 25°, 20° to 30° and 20° to 35°. Maximum germination was obtained at these temperatures with potassium nitrate, but germination was less than half as much with water.

After two year's storage, germination with water had not increased.

No germination was obtained at 30°C at any time and only low germination at 25°.

INJURIES TO SEEDLINGS INDUCED BY CHEMICALS DISSOLVING FROM GERMINATOR TRAYS[1]

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In a recent article[2] aberrations in seedlings apparently caused by soluble zinc compounds were described and illustrated. Chemical analysis of the hardware cloth, or hail screen, used in construction of the trays demonstrated the presence of soluble zinc, probably present as zinc oxide or zinc carbonate. The typical injury was a stunting, deformation, discoloration, or occasionally a killing of the radicles. The abnormal seedlings were similar to those found in germination tests of crucifers treated with excessive dosages of zinc oxide or cuprous oxide. The plumules, not coming in contact with the toxic chemical, were not affected.

A copper germinator was delivered in March of 1938. The trays, although given a copper finish by an electrolytic bath, were in reality identical to those accompanying the ordinary galvanized germinator.

Soybeans placed on paper towels spread flat on the trays first exhibited the symptoms of chemical injury. Their roots were injured somewhat as soon as they reached the towels. Seedlings of carrot, celery, pepper and tomato were also injured when the seeds were germinated on blotters placed on the new trays. Radicles were severely injured as soon as they contacted accumulations of the deposited chemical. Carrot radicles were very intolerant of this material and radicles of most solanaceous species were usually abnormal. Only normal root development occurred in the clean portions of the blotters; inferential proof that the injury is caused by the chemical deposits. Within a few days circular and irregular spots were apparent on the surface of the blotters. Rarely long streaks formed and extended across an entire blotter. They were first of a grayish color not easily distinguished from the blotter but soon acquired a glistening metallic color usually tinted a slight greenish-yellow to brown. The deposition of zinc or possibly lead from the galvanized coating and the solder was thought to be responsible for the grayish color, while dissolution and accumulation of the copper finish accounted for the brownish tint.

As many as 50 discolored areas were counted on a number of 5 x 6 inch blotters. The spots were usually 1/4 to 1/2 inch in diameter, often nearly circular, but rarely very irregular. The chemical was deposited not as a solid blotch but as a wide band of 1/16 to 3/16 inch width enclosing an apparently normal area of the blotter. In every instance the underside of the blotter was definitely discolored to a greater extent than the upper side.

The trays were clean and entirely copper-colored when placed in use. Within three days many of the meshes were filled by chalky white drops of water, or, if allowed to dry, by thin white films of the deposited material. These accumulations always coincided with the discolored areas of the blotters. Several trays which have been left continuously in a humid atmosphere for three months are now nearly white due to the incrustations of the deposited chemical. Blotters left on the trays for several weeks were gradually coated until they were almost completely covered by films of the material.

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[1] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 277.

[2] Crosier, W. F., Patrick, S. R., and Willits, C. O. Zinc injury in germination tests. Proc. Intern. Seed Testing Assn. 9:257-262. 1937.

The toxic principle has diminished markedly through continued use of the trays. Attempts to secure injured radicles on twice-used trays has often been unsuccessful. Frequent washings of the trays would probably accelerate the removal of the chemical. Upon the advice of chemists who definitely stated that a lead or zinc compound was present and would prove troublesome for an indefinite period, several trays were covered with lead-free paints which are claimed to inhibit the passage of soluble chemicals. Aluminum paint, gray resin lacquer and a white enamel gave excellent finishes. The white enamel provided a very smooth durable surface. How long any paint will withstand the mechanical wear attendant with constant usage is not known.

SEED VALUE OF DE-HULLED OATS - PRELIMINARY[1]

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The seed of ordinary oats consists of the caryopsis losely enclosed in the flowering glume and palea, much the same as that of seeds such as emmer, spelt, timothy, and canary grass. The caryopsis of barley commonly has the flowering glume and palea closely adhering to it, while in wheat it is threshed free of these parts. Exceptions to these are the cases of the hulless type of oats and the hulless barley, both of which are less frequently encountered in seed testing.

During the threshing process, especially when the grain is dry, some of the kernels are de-hulled. Analysts in the oat-producing regions are confronted with the problem of interpreting the seed value of these de-hulled oats in comparison with those which have the hulls on.

The behavior in the germination test of these de-hulled oats in comparison with those which have the hulls on, is of special interest. The most noticeable feature is the more prompt and regular development of the de-hulled seeds. This is shown in the growth which takes place in 48 hours at 25°C, as illustrated in Figure 1. The plumule, the radicle, and the seminal roots have all developed in the de-hulled seed, while in the hulled seed, only the radicle and one small seminal root have made their appearance. The irregularity of the germination of the hulled oats is shown in Figure 2. In this, three stages of development are found. The slow and rather abnormal development of the two seeds on the left indicate that the emergence of the plumules and root parts has been retarded by the hulls. The strong development of the seed on the right shows the more usual type of germination of the hulled oats. De-hulled oats, when germinated under these conditions, show uniformly strong development.

When the germination of the hulled and the de-hulled oats was continued in blotters for six days, both showed equally strong development. Likewise, tests for two weeks in soil showed that the growth of the de-hulled oats was equal to that of the hulled oats.

Experimental Results

Four lots of oats were tested in the laboratory, greenhouse, and field. A portion of the seed of each lot was de-hulled by hand in January and another portion was de-hulled in May, just before time to make the field plantings. Care was taken not to injure the caryopses as the hulls were removed. The seeds which were de-hulled in January were mixed back with the original lots until time for testing in May.

The hulled and de-hulled seeds were tested for germination early in June under three conditions; blotters in the laboratory at 20°C, sand in the greenhouse, and rows in the field. The duration of the tests ranged around six days in the laboratory, 10 to 14 days in the greenhouse, and 21 days in the field. No development of molds or other abnormal conditions were observed in any of the tests.

As shown in Table 1, the average laboratory germination for the normal oats was 98%, that of the oats which were de-hulled in January was 85%, and that of those de-hulled in May was 90%. The corresponding results in the greenhouse tests

[1] Contribution from the Montana State College, Agricultural Experiment Station. Paper No. 116, Journal Series.

Figure 1.
Comparison of rapidity of germination of hulled and de-hulled oats. Germinated 48 hours at room temperature.
Left - Hull on, plumule has not appeared.
Right - De-hulled, plumule, radicle, and two seminal roots have appeared.

were 95%, 75%, and 87%, while the results for the field were 89%, 76%, and 80%. It is apparent from these results that the oats which were de-hulled just before the germination tests were made had slightly greater viability than those which were de-hulled five months prior to that time, the differences being 5% in the laboratory, 12% in the greenhouse, and 4% in the field.

The advantages in germination of the normal oats over those de-hulled in January were as follows: laboratory, 13%; greenhouse, 20%; and field, 13%. These results are more striking in the laboratory and greenhouse, but less so for the field than those reported by Whitcomb and Hay[1] on oats de-hulled in threshing, in which case the differences were 5% for the laboratory, 2% for the greenhouse, and 32% for the field.

Summary and Conclusion

In this preliminary study with four lots of oats, the following points are of special interest:

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[1] Whitcomb, W. O. and Hay, W. D. Notes on the germination of broken seeds. Proc. Assn. Off. Seed Analysts North America. 1924: 38-39. 1925.

Figure 2.
Hulled oats germinated four days at room temperature, showing irregularity of development.
Upper left - Plumule, radicle, and one seminal root have emerged.
Lower left - Plumule has emerged and the hull has been pushed off by the radicle.
Right - The more usual strong development. The plumule, radicle, and three seminal roots have emerged.

1. De-hulled oats germinated more promptly and uniformly in the laboratory test than did the hulled oats.

2. Oats which were de-hulled just before testing showed greater viability than those which were de-hulled five months prior to that time, the differences being 5% in the laboratory, 12% in the greenhouse, and 4% in the field.

3. Normal oats showed higher germination than those de-hulled five months prior to testing, the differences being as follows: laboratory, 13%, greenhouse, 20%; and field, 13%.

4. It is planned to continue this study on a somewhat more extensive scale.

TABLE 1.
COMPARISON OF GERMINATION OF NORMAL AND DE-HULLED OATS IN THE LABORATORY, GREENHOUSE, AND FIELD.

Treatment		Germination		
	Laboratory number	Laboratory %	Greenhouse %	Field %
Normal seed - no treatment	1	99	95	85
	2	98	90	92
	3	100	100	95
	4	94	95	84
Average		98	95	89
De-hulled in January	1	80	70	76
	2	88	70	82
	3	86	78	75
	4	86	82	71
Average		85	75	76
De-hulled in May	1	92	89	84
	2	88	85	76
	3	87	91	82
	4	93	83	78
Average		90	87	80

GERMINATION STUDIES OF THE HULLESS SEEDS OF REED CANARY GRASS

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Reed Canary Grass (Phalaris arundinacea) has become of economic importance in many sections of the country during the past few years. This is especially true in Wisconsin where large areas of marsh lands are being planted each year.

This grass makes its best growth on fertile, moist, or swampy soils of a peaty nature. However, it can be grown on high, well-drained, productive soils if there is sufficient moisture and other conditions are suitable.

In the central states area, spring seeding is most suitable for cultivated soils. On these lands a longer seeding season is usually possible and good seed beds can more easily be prepared. Reed Canary Grass seed germinates very slowly. Under ordinary temperature and moisture conditions, it requires from 24 to 40 days for complete germination. This point must be considered in making fall plantings.

The use of Reed Canary Grass for hay is increasing. The best quality of hay is obtained from thick stands pastured early in the season to retard the hay making period and to produce leafier crowns and stems. The early season growth is usually very heavy and the stems coarse.

Seed production of Reed Canary Grass is developing rapidly. Until comparatively recently, most of the seed used in this country was imported from Europe. At the present time, however, practically all of the seed is grown in this country. Wisconsin produces large quantities each year. Some of the harvesting is done by hand, but in many localities, special machinery is employed.

The past four or five years have seen a steady increase in the number of samples of Reed Canary Grass seed received at the Wisconsin State Seed Laboratory. Most of the samples have been of good quality, however, some have had the appearance of improper care in harvesting, threshing, and curing the seed.

Getting a good stand is the main thing in growing this crop because once established, it will take care of itself. Several features enter into the proper handling of seed after threshing; it must be properly cleaned and stored in such a manner as to prevent heating in storage.

Seed of good quality and which is properly cleaned should produce a good germination test. This cannot be accomplished with light and hulless seeds. It is the latter type which I wish to discuss.

In 1935, quite a few samples of Reed Canary Grass contained appreciable percentages of hulless seeds and a series of germination tests were made with these seeds. The series of tests has been continued each year since that time. Wherever possible, 200 seeds were used for the test; in some samples, however, only 100 seeds were obtainable due to the size of the sample or to necessity of better cleaning.

In 1935, 18 samples were tested; in 1936, the number dropped to 16. The 1937 samples numbered 27 and in 1938, the number tested was 49. All tests of the hulless seeds were made in the same manner as with the unhulled seed. These seeds were placed on filter paper moistened with a 0.2% solution of KNO_3 in petri dishes and placed in the germinator at a temperature of approximately 20° to 30°C. All samples of the hulless seeds were badly attacked by mold, while the samples of unhulled seeds did not show any sign of molding.

As a result of most of these tests, the conclusion might be reached that hulless seeds of Reed Canary Grass are of little value for seeding purposes. However, more tests must be made on these hulless seeds before a definite statement can be made.

TABLE 1.
LABORATORY GERMINATION TESTS OF HULLESS SEEDS OF REED CANARY GRASS, SHOWING GERMINATION AND DEAD SEEDS - TWO YEARS' RESULTS

Sample No.	Percentages of germination and dead seeds			
	Test No. 1		Test No. 2	
	Germination	Dead	Germination	Dead
1935 Crop.				
Aebischer	5	95	7	93
Behrend	45	55	23	77
32	14	86	-	-
102	11	89	7	93
203	20	80	-	-
220	11	89	-	-
295	0	100	-	-
296	11	89	-	-
297	18	82	-	-
409	10	90	-	-
456	7	93	-	-
495	8	92	12	88
522	6	94	-	-
523	58	42	58	42
603	11	89	9	91
784	12	88	8	92
839	15	85	-	-
1665	2	98	4	96
1936 Crop				
13	30	70	-	-
14	24	76	-	-
31	27	73	-	-
55	46	54	-	-
92	14	86	22	78
159	41	59	43	57
179	59	41	65	35
195	0	100	-	-
206	9	91	-	-
267	29	71	17	83
316	4	96	3	97
339	32	68	25	75
351	17	83	23	77
803	4	96	-	-
827	9	91	9	91
861	4	96	0	100

TABLE 2.
LABORATORY TESTS ON HULLESS SEEDS OF REED CANARY GRASS, SHOWING NORMAL GERMINATION, WEAK SEEDLINGS, AND DEAD SEEDS - TWO YEARS' RESULTS

Sample No.	Germination		Weak Seedlings		Dead Seeds	
	Test No. 1	Test No. 2	Test No. 1	Test No. 2	Test No. 1	Test No. 2
1937 Crop	%	%	%	%	%	%
17	22	25	4	4	74	71
19	35	21	6	4	59	75
28	53	60	2	4	45	37
29	67	53	6	3	27	44
40	26	29	10	7	64	64
54	49	50	3	1	48	49
75	7	16	4	2	89	82
88	51	56	12	9	37	35
92	6	12	0	1	94	87
128	20	19	6	6	74	75
130	20	12	3	3	77	85
160	20	10	2	1	78	89
201	11	14	3	3	86	83
210	14	13	0	4	86	83
233	17	15	1	2	82	83
241	22	40	6	6	72	54
242	37	31	2	4	61	65
243	37	30	10	12	53	58
449	10	10	3	6	87	84
489	17	25	4	0	89	75
533	1	-	0	-	99	-
634	10	-	7	-	83	-
635	18	8	2	1	80	91
720	2	6	0	0	98	94
1938 Crop						
7	8	13	2	1	90	86
12	15	18	1	6	84	76
17	31	22	2	5	67	73
28	42	43	9	7	49	50
31	43	31	1	6	56	63
39	26	16	5	5	69	79
40	31	36	7	8	62	56
54	32	25	2	3	66	72
88	46	52	8	10	46	38
92	3	3	0	1	97	96
130	18	14	4	6	78	80
198	18	26	5	3	77	71
199	20	20	2	3	78	77
200	13	-	5	-	82	-

(Continued on next page)

Sample No.	Germination		Weak Seedlings		Dead Seeds	
	Test No. 1	Test No. 2	Test No. 1	Test No. 2	Test No. 1	Test No. 2
1938 Crop(cont.)	%	%	%	%	%	%
233	6	11	0	5	94	84
241	32	34	2	6	66	60
242	31	34	9	6	60	60
370	16	5	5	5	79	90
371	4	0	2	3	94	97
396	23	22	11	3	66	75
397	5	6	2	2	93	92
449	7	6	2	3	91	91
489	24	20	5	3	71	77
602	0	0	0	0	100	100
622	13	9	5	2	82	89
634	8	6	2	2	90	92
682	1	2	0	0	99	98
717	10	12	2	3	88	85
718	6	11	2	4	92	85
719	17	17	3	4	80	79
720	2	4	0	1	98	95
S-736	7	7	0	3	93	90
810	24	32	8	4	68	64
869	2	12	2	3	96	85
870	4	5	3	1	93	94
979	11	8	0	1	89	91
1145	10	12	0	2	90	86
1404	2	1	0	0	98	99
1472	14	-	3	-	83	-
1521	54	52	10	10	36	38
2110	18	17	1	0	81	83
3694	0	-	2	-	98	-
4498	11	8	0	4	89	88
4601	12	12	2	2	86	86
4602	3	4	1	0	96	96
7067	3	1	1	1	96	98
7705	24	19	2	5	74	76
7706	26	33	4	4	70	63
Green Lake County Lot	9	16	2	4	89	80

TREATMENT OF SEEDS WITH INDOLEBUTYRIC ACID AND ITS EFFECTS[1]

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Julius Sachs, in 1882 (18)[2], first made the plant physiologists auxin-conscious, but it was not until a generation later that the first of these chemicals was isolated and identified. Most of the work has been done on coleoptiles, but seeds also contain auxins or growth producers.

Cholodny (2), Laibach (12), and Pohl (17) all stated that the growth hormone is present in the seed endosperm. When Pohl removed or punctured the seed coat and aleurone layer to allow outward diffusion of the growth hormone, he found that the growth in length of the coleoptile decreased by as much as 25%. When the wounded seeds were treated with growth hormone paste, the coleoptile elongated to almost normal length. He concluded that the growth hormone is not produced in the coleoptile tip but is given off by the endosperm and then activated by the tip. The tip, he stated, is the center of distribution.

Laibach and Meyer (13), working with Helianthus, showed that the amount of growth substance present varies with the stage of development. During seed germination and early growth, it is abundant; during the period of vigorous vegetative activity, it is relatively scarce; and then it is high again as the plant comes into fruit. They found it is present in fruits and seeds at the greatest concentration during early germination, and again high in concentration at the time of fruit formation; also that seedling plants grown in darkness lose their ability to form the growth substance rather soon, while normal plants placed in the light retain this ability for a long time.

Cholodny (2), Laibach and Meyer (13), Kozl, Haagen Smit, and Erxleben (6, 7, 8, 9, 10, 11) found that the growth substance stored in seeds is liberated in an active form following hydrolysis and the activity of enzymes. When wheat seedlings were treated with X-rays, those with auxin present were less sensitive. When only the coleoptiles of Avena were X-rayed, there was almost no effect. This is explained by Pohl's observation that the growth substance moves from the endosperm to the tip.

Avery, Burkholder, and Creighton (1), working with Helianthus and Nicotiana, however, could not detect the presence of the growth hormone in seedlings up to three weeks of age, even though the plants were growing rapidly. They made their determinations by the Went Avena method.

Goodwin (4) stated that in Solidago the young leaves are the chief sources of auxin. The seedlings have a leaf which elongates rapidly and produces auxins which inhibit the growth of the lower leaves.

Cholodny in 1935 stated that the endosperm of the germinating seed produces auxin while the embryo uses it up or destroys it. He called this seed-produced auxin a germination hormone (Keimungshormon). Its influence is that it causes growth of the embryo and, therefore, of the embryonic roots.

Cholodny reported the presence of a growth promoting substance in the hydrated endosperm of sprouting oats and corn seeds which acts in the same way as

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[1] Approved by the Director of the New York State Agricultural Experiment Station as Journal Paper No. 278.

[2] Numbers in parenthesis refer to Literature Cited.

the growth hormone present in the coleoptile. It is present in greatest concentration during early germination.

Then Marmer (16), who worked with wheat seedlings, found that growth substances brought about a decrease in the growth of the primary root, coleoptile, and first leaf; and an increase in the number of secondary roots. Thimann (19) also found that roots, buds, and stems all behave comparably, their growth being inhibited by relatively high and promoted by relatively low auxin concentration. Leonian and Lilly (14) working with heteroauxins on corn seedlings concluded that heteroauxin is a growth inhibiting rather than a growth promoting substance.

As you know, there is abundant material now appearing on this fascinating subject of auxins, which is as intriguing to plant workers as the endocrine glands are to the animal biologist. The evidence is so varied and so contradictory at times that it is hard to marshall a coherent survey. With the exercise of a little juris-prudence enough of the present evidence could be ignored, and any one could prove almost any statement.

Methods of Procedure

The results of the work of the investigators, only a few of which can be mentioned here, suggested the study of the effect of indolebutyric acid on seeds. Why would not the root-producer hasten the germination of seeds which is at best a very slow awakening? Several sets of experiments were set up. Representative seeds from the Gramineae to the Compositae were chosen and treated with four different concentrations of "Auxilin", which is a solution of indolebutyric acid in Ethyl alcohol put up by the Pennsylvania Chemical Corporation. These were placed to germinate in the regular manner along with similar series, using water as a control. The light and the temperature factors were also partially checked by conducting the experiments in triplicate in the daylight and in the dark germinators; and with a constant 20°C and 20-30° alternation.

Each experiment was set up so that the following ten points could be observed:

1. The water check
2. Those soaked in water 12 hours and decanted
3. Those soaked in water 12 hours and treated with dilution No. 0 which is 1 part of indolebutyric acid to 800,000 of water and decanted
4. Those soaked in water 12 hours and treated with dilution No. 1 which is 1 part to 400,000 and decanted
5. Those soaked in water 12 hours and treated with dilution No. 3 which is 1 part to 100,000 and decanted
6. Those soaked in water 12 hours and treated with dilution No. 5 which is 1 part to 25,000 and decanted
7. Treated with dilution No. 0 without previous soaking
8. Treated with dilution No. 1 without previous soaking
9. Treated with dilution No. 3 without previous soaking
10. Treated with dilution No. 5 without previous soaking

Each treatment contained one hundred seeds.

Several other interesting experiments developed as this work progressed; such as putting seeds on both cotton and blotters treated with auxin to determine the comparative inhibitory effect, if any, of the substratum; germinating the seeds by the Copenhagen bell jar method to determine if there was any diffusion from the treated substratum. Treating seeds with picric acid to determine

the effects of a poisonous acid. But interesting as the results of these and other experiments were, they shall not be touched upon in this paper.

In the treatments, Kentucky bluegrass, timothy, red clover, white clover, crimson clover, celery, and lettuce were used. The inhibited reaction to the auxin for all of them was the same. There were, of course, individual peculiarities in the reactions, such as the lack of chlorophyll at the tip of the primary leaf of Kentucky bluegrass.

In the treatment 3 or 5 cc of the auxin dilution, depending on whether blotters or cotton was used, were put into the petri dish with the substratum. To avoid as much variation as possible, all parts of each set of treatments were conducted at the same time. After the first results, it was apparent that there was no need to fear that the abnormally swift growth would tax the capacity of the germinators.

The water checks were used as a basis of comparison. These were prepared as all routine tests except that they were in glass dishes.

Discussion of Results

Light, or lack of light, seemed to exert no noticeable variation on the normal reaction of the seeds to the indolebutyric acid. The temperature, too, had a negligible effect. Putting the tests in both the day light and dark germinators, however, showed that the untreated seeds were positively phototropic and the indolebutyric acid treated ones decreasingly so, depending on the concentration of the solution. The higher the concentration of the acid the less positive was the phototropism of all the seeds. The sprouts of dilution No. 3 and No. 5 showed little or no attraction to the light. Often the hypocotyl, cotyledons, and plumule were oriented to or against the light with the weight of the stem and gravity seemingly being the only determinents. In dilution No. 5 treatments the sprouts were, if developed at all, often procumbent. Since the water checks were always positively phototropic and erect, this seems to show that the indolebutyric acid upsets the normal tropisms of the seedlings. The stronger the solution the less evident the normal tropisms.

In any temperature tested the indolebutyric acid was toxic. Many of the abnormal sprouts produced by the indolebutyric acid are similar to the abnormal sprouts found in routine germination tests. This raises the question whether seeds, because of age, storage conditions, maternal tissue, genic constitution, or nutritional environment during development might be carrying an overdose of auxin.

In order to bring more evidence on this point, seeds were soaked in water for periods varying from 4 to 24 hours. When germinated, those seeds that were soaked showed a higher germination and larger sprouts than did the water check or the auxin treated seeds. This was especially true in the case of the legumes. The roots and stems were longer and sturdier, as if the soaking had diluted and diffused out any inhibitor or auxin present. In the sets that were soaked and then treated with dilutions of indolebutyric acid, the results of dilutions No. 0 and No. 1 showed healthier, more normal sprouts than the unsoaked, auxin treated tests.

The indolebutyric acid stunted the growth of the primary root. In the more dilute solution, the root was slightly thickened and shortened. The root hairs were present and of normal length. The hairs were, however, more dense than normal, just as though the usual number were present, but when the root itself

was inhibited in growth in length, a telescoping process took place and they were closer together. The hypocotyls in the dilutions No. 0 and No. 1 were erect and lost only a small amount of their phototropism. They were only slightly curved; some of this curvature was straightened out with age.

In the higher dilutions, the toxic effect was very evident, and the abnormalities were shown in all the genera treated. The higher the concentration the shorter the root. In dilution No. 5, the radicle at times barely broke through the seed coat. The point of union of the hypocotyl and the radicle was, in all but a few exceptional cases, greatly swollen. The tissue was granular and appeared disrupted. In dilution No. 5, celery and legumes seldom produced root hairs at all. Many of the bluegrass sprouts had tumor like growths on the short radicles, and there were thin, secondary roots along the swollen hypocotyl. The primary leaves of the bluegrass often seem to grow faster than the sheathing coleoptile, the walls of which it burst, and buckle on itself growing out like an elbow near the base of the hypocotyl. In dilution No. 5 there were frequently no root hairs. The surface of the radicle in these cases had a smooth, glassy texture. When there were root hairs they were scattered in small tufts. At times the root hairs were all on one side of the radicle. In dilution No. 5 the roots generally showed a negative geotropism, curving and bending up from the substratum as if to get away from a poison. The root tip often projected from the blunt swollen root like a nipple.

In dilutions No. 1, No. 0, and No. 3, and infrequently in No. 5 after a time the roots resumed growth, and produced a normal or almost normal root. The root tip produced an appendage to the swollen radicle that was long and covered with normal root hairs. These sprouts, however, never attained the size of the water checks.

Frequently, in the lettuce treated with dilution No. 5, roots radiated out from the base of the hypocotyl like a modern cycad, or a fossil Lepidodendron. Concerning this appearance of adventitious roots, Zimmerman and Hitchcock (20) have shown that indolebutyric acid and Napthaleneacetic acid are the most effective substances for the stimulation of new and adventitious roots. Link (15) suggests that auxins are harmful to roots in relatively high concentrations. The roots of the bean plant treated with heteroauxins resembled the roots of certain bog and muck soil plants. Therefore, hyperauxony of these substrata may be, in part, responsible for the characteristic bog plant roots.

The stems, hypocotyls, and coleoptiles of these treated seeds were abnormally twisted and curved. At times, they formed spirals and twisted upon themselves. They were never as long as the water checks. These twists increased in number and intensity with the strength of the concentration of the indolebutyric acid.

An observation that ought to be of particular interest to seed analysts was found in the soaking of the legumes. Simply the soaking process very materially lowered the percentage of seeds remaining hard at the end of the test.

Conclusions

Indolebutyric acid in the concentrations of 1 part to 800,000; 1 part to 400,000; 1 part to 100,000; 1 part to 25,000 inhibit seed germination and also cause abnormal seedlings when the seeds are treated.

Many of the abnormal sprouts normally found in the routine germination tests can be duplicated by treatment with indolebutyric acid. This might suggest that the seeds may normally contain an auxin, and when it is present in too high a

concentration it acts as an inhibitor. Even the most lethal poison can be used as a valuable therapeutic agent if taken at the proper time in the proper dosage. Indolebutyric acid may be just such a potential treatment for seeds and the concentrations which were tested may have been too great to stimulate growth.

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SELECTING BEET "SEEDS" FOR GERMINATION TESTING (ABSTRACT)

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From time to time attention has been drawn to the desirability of using care, or some specific method or scheme for preparing or selecting the bolls, clusters, glomerules or "seeds" of Beta spp., for germination testing. The circulation of a referee sample of mangel beet seed in one region and printed statements concerning it, led the writer to give additional attention to this subject.

It seems evident that European laboratories have for some time used a very intriguing laboratory procedure in selecting the seeds of all beets for the germination test. A brief discussion of this is given in the "International Rules for Seed Testing". At the recent Congress, an objection which seems to have no substantiating facts, was apparently raised to the inclusion in the Rules of the use of a mechanical counter when counting out the 4 x 100 clusters for germination testing.

In 1926, Jackson[1] made repeated trials of three methods of selecting the seeds for the germination test and concluded that the pouring method, that is, when the composite sample was poured out upon the working board and a series of 100 seeds taken indiscriminately, gave the widest variation from the expected results and should not be used. Mixing the sample in a bowl gave erratic data and could not be depended upon. Mixing and reducing the sample to about 400 seeds thru a Boerner mixer and sampler gave the most consistent and reliable results and very close to the expected frequency.

In 1938, Skuderna and Doxtator[2] used a Boerner grain sampler to secure a mechanically reduced random sample. Their results indicate the need of a random sample of beet seed mechanically reduced to proper size. They concluded that the Boerner sampler, or some other equally effective mechanical device, is essential to the securing of a representative sample.

In the work herewith briefly reported, the writer compared various mechanical devices using a specially prepared sample and concluded that:

1.- In the case of samples, slightly larger than the small packets in which the entire packet contents may be used, it is safe to pour the entire contents out upon an even surface and by means of a series of serpentine motions thru the sample from side to side to thoroughly mix the sample from which the series of seeds are selected indiscriminately.

2.- For reducing the larger samples, the bifurcated scoop, the Jones sampler such as is used for sampling ores and other dry materials, other trough samplers, and the Boerner sampler all proved satisfactory.

3.- The mechanical suction counter used in conjunction with a 2 mm sieve to remove the finer inert material proved entirely safe and reliable. The composite sample of about 50 grams is poured on the sieve, shaken just enough to sieve the finer material thru and then a swath of sufficient seeds is taken at random and

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[1] Jackson, Marie. Notes on some phases of beet seed germination. Proc Assn. Off. Seed Analysts North America. 1926: 35-37. 1928.

[2] Skuderna, A. W. and Doxtator, C. W. Germination tests with sugar beet seed. Jour. Am. Soc. Agronomy. 30, 4:323-333. 1938.

placed directly upon the counting plate of the mechanical counter. The mechanical counter appeared to show no biased selection of the various sized seeds when compared with the specially prepared type sample.

All of the mechanical devices when used with care and judgement proved effective in reducing the beet seed sample to the desired size, and finally, the suction counters which are coming into general use were found to be dependable in that they did not appear to be selective when securing the 100 seeds.

THE USE OF TRIAL GROUNDS FOR VARIETY TESTING

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The Canadian Seeds Act, Section 9, states "Seeds or plants that are falsely represented as to age, viability, quality, grade, variety, origin, or description, shall not be advertised, offered, sold, or had in possession for sale for the purpose of seeding or planting in Canada."

This paper deals with vegetable seeds only.Professor Munn has dealt with this subject at some of our previous meetings, and the writer is certain that he will agree when the opinion is offered that it is of equal importance with the regular analytical test of samples submitted for analysis. The presence of weed seeds with a few exceptions is of minor importance, as thinning of the seedlings and cultivation removes them. Except in a few instances, it is not possible to determine purity as to variety from an examination of the seed. Yet, if an inferior stock of vegetable seed has been supplied, or a variety substituted for that required, the results are disastrous to the market gardener. He may plan to supply a certain market at a given period when the demand for a certain variety is good. If a variety maturing at a later time is substituted, he loses the market, his labor, and utilization of the land. If an inferior stock or variety is supplied, he also suffers a financial loss. Unfortunately, the only means of determining this is by cultural test in the field and when the results are obtained, it is too late to remedy the matter as far as the purchaser of the seed is concerned.

Our difficulty in Canada is that most of the vegetable seed used is imported. The importer may, in good faith, purchase inferior stocks but the grower is outside Canadian jurisdiction and it does not seem fair that the retailer should be held responsible if it can be shown that responsibility lies elsewhere.

The writer's personal experience has been that every reputable seed merchant in Great Britain maintains trial grounds for testing the purity of variety and quality of seed stocks which he offers for sale and the same presumably applies in the United States with bona fide seed merchants. It might also be stated that the use of commission packets as we understand them in North America is not general in Great Britain as all the leading seed merchants fill their own packets bearing their name and address. They make comparative trials of their own stocks of seed with those obtained from other growers, thus a check is made on the maintenance of quality of their stock seed and corroborative evidence is provided if complaints have been made rightly or wrongly by their customers.

Since the consignors of vegetable seeds to Canada are outside our jurisdiction, in respect to purity of variety, we have adopted the plan of informing the consignee as to the quality of the seed he imports after field trials have been made. These trials are conducted principally at Ottawa and Sackville, N. B. The work at Sackville was commenced in 1929 simultaneously with the opening of the new laboratory for the Maritime Provinces of Canada. At Sackville, the general plan is to select two kinds of vegetables for trial for a period of five years and at the end of that time to publish a summary of the results (although an annual report is also available) which is distributed amongst importers of the seeds tested. By this means they are able to appraise the quality of the seed they have imported and sold. If the results on seed obtained from a certain

grower were consistently poor, they would probably obtain future requirements from another source.

Purity of variety trials are also conducted at the Central Experimental Farm, Ottawa. Due to climatic conditions in the Maritime Provinces, there are some kinds of vegetables which it is not possible to test at Sackville, such as melon, pepper, tomato, onion, and corn. These are tested at Ottawa. The samples are obtained in the first instance by the Collector of National Revenue at the port of entry into Canada. He forwards the samples to the nearest seed laboratory for analysis and after this has been made, the remainder of the sample is sent to Ottawa. These are then assembled and distributed between Sackville and the Experimental Farm, Ottawa for growing test, provided that kind of seed has been selected for trial in that particular year. During the present year, we are testing squash and lettuce with a total of over 1,200 plots covering 3-3/4 acres of land. Inspectional notes are made during the entire growing period and a final inspection at maturity.

The kinds already tested at Sackville for the full 5-year period are beets, peas, beans, and turnips. The descriptive forms on which particulars are entered during the growing period cover every essential detail such as apply to the top, stem, root, flesh, quality, flavour, disease and insects, season (early, mid-season or late) field germination, days to maturity, profile and other remarks, also laboratory germination, name of consignor and consignee.

Our field technique is as follows:

Rows are 30 feet in length and tests are made in duplicate, the latter being placed in another part of the field. This compensates for local conditions. Seeding is performed about the end of May and notes taken at intervals after the first appearance of the seedlings. The plants are thinned according to habit of growth. Final inspection is made at varying times:

Leaf lettuce - when 10% of the plants have developed the central whorl of leaves.

Head lettuce - when 10% of the heads are hard.

Beet - when 10% of the roots are 2½ inches in diameter.

Rutabaga - when 10% of the roots are five inches in diameter.

Peas - when 10% of the pods are filled.

Beans - two final inspections - first when 10% of the pods are filled and second, when seed is ripe.

Pumpkin - when the skin is fully coloured.

In root crops - 100 roots are examined and dissected, the contour being also noted.

For the past two years, inspectors have taken samples of vegetables from commission boxes for field trials at Sackville. The containers bear the name of the firm which filled them, the only additional information we have being that of the store in which they were offered for sale. Field days were arranged to which those interested were invited so that they could see the produce of the seed they had sold.

During the past few years, we have noticed a progressive improvement in the quality of vegetable seeds imported into Canada. This may be due to competition, but we believe that growers are aware that field trials will be made of their shipments. It is difficult to prohibit a dealer from buying inferior seed if profit is his only thought but we can indicate where the best stocks can be procured.

CLASSIFICATION AND GERMINATION OF HERB VEGETABLE SEEDS.

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In order to get a more definite understanding regarding the distinction between the herb seeds classed as just herbs and the ones classified as vegetables by the various states listing herb seeds in their vegetable laws, the writer took the liberty of writing to the Official Seed Analyst in each of these states enclosing a list of the herb seeds which are most in demand. A request was made of each analyst to place a "V" for vegetable or "H" for herb before each variety, thus indicating which they considered vegetable or herb. Six letters were sent out and the answers tabulated as received are as follows: All analysts designated Anise, Balm, Sweet Basil, Borage, Catnip, Chervil Curled, Coriander, Horehound, Hyssop, Lavender, Sweet Marjoram, Rosemary, Rue, Saffron, Sage, Summer and Winter Savory, Thyme, and Wormwood as herbs. All analysts designated Asparagus, Cardoon, Celeriac, Chicory and Corn Salad as vegetables.

The seeds for which a difference of opinion exists, and the manner in which they are classified are as follows:

	Vegetable	Herb
Caraway	1	4
Chives	1	4
Cress	4	1
Dandelion	4	2
Dill	1	5
Fennel Florence	1	4
Fennel Sweet	1	5
Rhubarb	5	1
Sorrel	3	3

This shows nine varieties which need some form of ruling to give them a classification in order to meet the various state laws.

Germination Standards of the Various States

	Michigan	Missouri	Ohio
	%	%	%
Cardoon		60	60
Celeriac	55	50	65
Chicory		65	65
Dandelion		60	60
Dill	60	60	60
Corn salad		70	70
Rhubarb	60	65	60
Sage		60	60
Sorrel		60	60

Germination Standards of the Various States (Cont.)

	Michigan	Missouri	Ohio
	%	%	%
Summer savory		60	60
Sweet basil			50
Sweet fennel		60	60
Sweet marjoram		65	65
Thyme		60	60

New York and West Virginia require the vendor to set his own standards.

The writer also asked for information as to the germination methods used for each variety. Only three states answered this question; one state very fully; one state reported that the herbs mentioned gave no special difficulty; and the other stated that they had poor germination with seeds of the kitchen herbs. The writer, likewise has had very poor success with these seeds and does not feel qualified to blame either seed or the seed growers.

It might also be added that an attempt is being made to get a definite decision on the difference between Sweet Fennel and Florence Fennel. Some shippers claim they are the same and supply the same seed for both. Others list them separately yet use the same seed. Bailey's Cyclopedia lists Florence or Sweet Fennel as the one variety, Foeniculum dulce, an Italian vegetable in the American trade, The common Fennel (Officinale), an annual herb used for seasoning, is not listed in the seed catalogues as far as could be determined. Any information regarding this question would be appreicated, since some of our trade are requesting this seed.

SUMMARY OF CLASSIFICATION OF LIST OF PLANTS AS TO WHETHER HERBS OR VEGETABLES BY DELEGATES AT THE ANNUAL MEETING OF THE ASSOCIATION OF OFFICIAL SEED ANALYSTS OF NORTH AMERICA AT GUELPH, ONTARIO, CANADA, JUNE 21, 1938.

Plant	Number which classed it as:		Plant	Number which classed it as:	
	Herb	Vegetable		Herb	Vegetable
Sweet basil	31	1	Dill	30	2
Borage	27	1	Florence fennel	30	2
Caraway	29	1	Rhubarb	2	30
Cardoon	6	5	Rue	30	1
Celeriac	5	27	Saffron	28	1
Chervil, Curled	6	19	Sage	31	1
Chicory	4	28	Summer Savory	20	8
Chives	4	26	Winter Savory	23	6
Coriander	31	1	Sorrel	17	12
Corn salad	1	31	Thyme	28	1
Cress	2	30	Tobacco	18	1
Dandelion	2	30			

All participants classed the following as herbs: Anise, Balm, Sweet Fennel, Catnip, Horehound, Hyssop, Lavender, Sweet Marjoram, Rosemary, and Wormwood.
All named asparagus as a vegetable.

Editorial Note: Mrs. Ethel E. Pattison, International Seed, Inc., New York, N. Y., appeared on the program and discussed some phases of commercial seed testing, using as a title for her talk: "Criticism -- Self and Otherwise". She furnished no written manuscript, therefore her paper does not appear in these Proceedings.

PHOTOGRAPH TAKEN AT THE ASSOCIATION OFFICIAL SEED ANALYSTS MEETING IN GUELPH, ONTARIO, IN JUNE, 1938.

TOP ROW: Iwah H. Everitt, John Dawson, George A. Elliott, H. H. Miller, F. A. McLaughlin, N. D. MacKenzie, Cecil Tapp, Earl M. Page, E. H. Toole, W. A. Davidson, N. G. Lewis, George P. Steinbauer. SECOND ROW: Dolores E. Weimer, Francis H. Adams, Harry E. Vegiard, A. C. Heise, L. A. Moore, Macy Spracher, Marjorie B. McKenzie, Ruth Evans, Albina F. Musil, A. Hope, Vera Drake. THIRD ROW: Fred H. Henke, Mrs. J. E. Merkel, Alma Everard, Alice M. Andersen, Mary C. Mowry. FOURTH ROW: Mary Teschke, Helen C. Horn, Chas. A. Stahl, Stewart Patrick, C. W. Leggatt, B. F. Forward, W. F. Cameron, Edith C. Higgins, Leota Thurlimann, Frances K. Shore, Vivian Kearns Toole, Louisa A. Kanipe. FIFTH ROW: M. T. Munn, W. H. Wright, Fred S. Emmet, Willard Crosier, C. N. McIntyre, G. A. Scott, W. A. Price, Mrs. H. H. Miller, Regina B. Schulte, Grace H. Blakeborough, L. N. Allen, Clara Mangelsdorf, J. Barnes, W. A. Wheeler, Helen B. Peebles, J. C. Noble, J. E. Merkel, Jessie Anderson. BOTTOM ROW: Frank H. Spanier, Bessie G. Sanborn, C. N. McIntyre, R. H. Porter, W. O. Whitcomb, M. Tobin, Emma F. Sirrine, C. M. Bass, Clifford Corneli, W. W. Oppel, J. A. Pepin.

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